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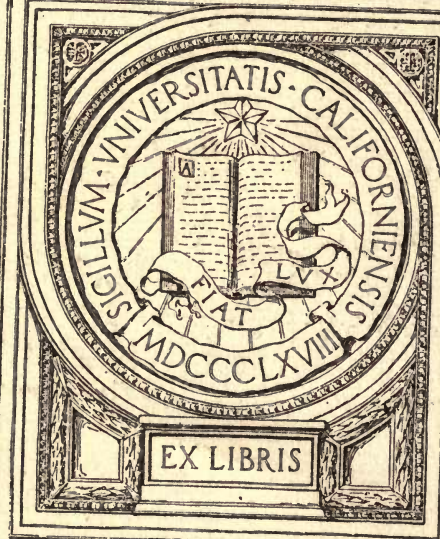

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MODERN
PROPAGATION OF TREE FRUITS

BY

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FIRST EDITION

FIRST THOUSAND

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PREFACE

In preparing this little book three important factors were kept in mind. First, only to include those practices of propagation which are in general use and which are accepted by the orchardist and the commercial nursery man as being the most important. Second, to furnish in a condensed form such information on propagation as will enable the general fruit grower to follow out the practices. It is assumed that the average fruit grower has a general knowledge of the various methods of propagation, hence the many confusing details are here omitted.

Third, an attempt is made to follow rather closely the methods employed by the arger commercial nurseries and to contrast these with the similar operations of the orchardists. The fruit grower who buys his nursery stock desires to know something of the methods whereby it is produced. The student of Horticulture needs a general knowledge of nursery work and how to apply it to either commercial or home use. It is hoped that the work is sufficiently clear that any interested fruit grower can successfully produce his own trees, thereby creating a desire to know more and to do greater things.

To all those who have contributed to the work in any way, my thanks are due. On the following page is printed a list of those I am especially indebted to.

B. S. Brown.

Orono, Maine.
June, 1916.

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MODERN PROPAGATION OF TREE FRUITS

CHAPTER I

SEED FOR PROPAGATION

PRACTICALLY all of our more common varieties of fruit do not "come true to seed," hence the usual methods of budding and grafting have to be resorted to in order to perpetuate standard varieties. Some few of our fruits can be grown from cuttings, some do best by budding, while others are usually grafted. No particular method is necessary or vital to each kind of fruit, but the various operations now employed are the result or outgrowth of efforts to economize in propagation.

From the standpoint of the practical orchardist the growing of nursery stock is usually left to companies or independent concerns which make that branch of horticulture their chief business. The vast number of new orchards now set every year make the growing of nursery stock of more than passing interest, and it is becoming the business of up-to-date orchard men to look deeper and deeper into the "why" and "how" of propagation. While it may seldom be feasible for an orchardman to grow

his own stock it is always advisable to know as much about the business as possible.

The work of propagation divides itself naturally into two groups. One, the modern nursery company whose chief business is to grow young trees. Such companies manifest little interest in the production of fruit, growing only what is necessary for the work of production. The other is the orchardist who desires to grow his own stock or to carry on some experiment in connection with his orchard work. Such men are responsible for much of the advancement in horticultural knowledge and their ability should have full recognition among all students of the subject.

Investments in Nurseries. The U. S. Census of 1910 reports 80,000 acres actually employed in the production of nursery stock. This represents an increase of thirty-five per cent over that of the ten preceding years. The capital invested in the above nursery companies approximate $21,000,000. This represents one hundred per cent increase or a doubling in value of the ten-year period.

Ninety-eight per cent of this business is handled by companies which make that their chief business, while the two per cent represents the work of the orchardists. In 1910 there were 2470 nursery concerns in the United States having an average investment of $8348. The distribution of nursery companies is fairly even over the United States. The bulk of the stock, however, is grown in the central States; diminishing toward the north or south. Some of the leading States and the value of their business are represented by the following figures:

New York	$4,355,000.00
California	2,703,000.00
Texas	1,236,000.00
Kansas	948,000.00
Pennsylvania	922,000.00
Minnesota	863,000.00
Ohio	860,000.00
Iowa	845,000.00
Illinois	822,000.00

Not all parts of the country show increases in the nursery business. A number of sections show decreases in the decade following 1900. It is especially noticeable that the greatest decline comes from sections that were in the " boom " period in 1900 and have since fallen back to their productive level. Some of these are the New England, Virginia, Ozark and Colorado sections.

Current Nursery Practice. Nursery practice all over the United States is founded on fairly definite general principles. The details, however, necessary for the putting of the principles into practice are widely variable due to the differences in local environment. As one would expect the difference in climate between the north and the south or the east and the west is such that many modifications of the common practices are necessary in order to expedite work or to facilitate ease or convenience in handling the stock. However, when one gets a good working knowledge of the methods of propagation for any one section of the country, one can, by small changes in practices to suit the needs of the local conditions, grow good

nursery stock in any part of the country. It is therefore desirable in this discussion to give only the more fundamenta operations and leave to the judgment of the reader such changes as are necessary to suit the work to his particular locality.

Seed. The first step in the work of propagation is to secure good seed. Very few of our common fruits will grow well from cuttings, hence some kind of a seedling must be grown on which the standard varieties can be budded or grafted. It is therefore necessary to get good seed that will grow strong roots, or the resultant tree will be weak and below standard. It is also necessary to grow stock on which standard varieties can easily be united. There is a wide difference in the various fruits as to the strength of the union a graft will make, and also as to the life and vigor of the resulting tree. Nursery men quite generally agree upon the kinds of stock best suited for the various kinds of fruit. The following list gives the stocks used for the different fruits by the best nursery companies in the United States:

STOCKS FOR THE DIFFERENT TREE FRUITS

Apple (standard)	Common varieties.
	French crabapple.
Apple (dwarf)	Paradise.
Apple (semi-dwarf)	Doucine.
Pear (standard)	Chinese or Japanese.
	Kieffer and French.
Pear (dwarf)	Quince.
Quince	Common.

Almond	Bitter almond, peach or plum.
Apricot	Common apricot or peach.
Cherry (sweet)	Black Mazzard.
Cherry (sour)	Mahaleb.
Peach	Wild from Ken. and Tenn.
Plum (Eastern States)	Myrobalan.
Plum (Western States)	Myrobalan and Mariana.
Walnut	Black walnut.
Pecan	Own roots.
Chestnut	Native American.
Olive	Own roots.
Citrus fruits	Sour orange and pomelo.
Fig	Grown from cuttings.
Mulberry	Grown from cuttings.
Date palm	Suckers or off-shoots.
Banana	Suckers or off-shoots.

The above list comprises the most important fruits and the stocks mentioned are quite generally used throughout the United States. In certain localities other stock may be substituted but only to meet specific or unusual conditions.

Securing Seed. The securing of good strong virile seed is not always easy. Some are collected in various parts of the country, others are grown by the nursery companies for their own use, while still others are imported from Europe. The business of seed collecting has never been given much consideration in the United States; hence many of our most important fruit seed have to be imported. It is unfortunate that more attention has not been given

to home grown seed as there is ample proof that such can be had just as good if not better than the imported.

It seldom happens that the seed from the fruit of the more improved varieties are suitable for propagation work. They are usually low in vitality and often fail to germinate altogether. The longer the varieties in question have been known the less likely are the seed to be good. It is not only necessary that the seed grow well, but also that the resulting seedlings be strong, vigorous and free from diseases. Varieties that have been propagated vegetatively for a long period of years have gradually weakened in their seed-producing power. It therefore follows that the nearer one can get to the wild state in collecting seed the better will be the results.

The seed from the stone fruits (peach, plum, apricot, cherry, etc.), are collected to some extent in the United States. The peach seed comes mostly from the mountains and foot-hills of Kentucky and Tennessee. In this section it has run wild and simulated more nearly the conditions of its native country. The trees have had to fight for their own existence, and those that have survived are strong and vigorous. Where these cannot be obtained, access can only be had to the commercial varieties. A few kinds like the Salway and Elberta produce good seed and are often substituted for the wild ones. Unscrupulous nurserymen go direct to the canneries and driers and gather seed promiscuously. This often results in many weak and inferior specimens, resulting later in short-lived trees.

With apricots the seed is usually collected from natural fruit where the grafts have failed to take, or from those

that have grown up along fences, creeks, etc. Almonds are collected about the same way as apricots. Many almonds that come naturally from seed are bitter, hence have no commerial value other than for nursery work. Almost every orchard has some trees in it which have never been grafted, or the grafts have failed to take. These are usually separated at harvesting time and the fruit saved

FIG. 1.—An Orchard for Growing Myrobalan Seed in California.

for nursery work. It is not necessary that the almond seed be bitter in order to be used for nursery work, but they ought at least to be hard shells and selected from vigorous growing trees.

For plum stock several sources of seed are available. The most common is the Myrobalan which is used in the eastern and central United States. Most nurserymen prefer to import this variety from Italy, where it grows wild and

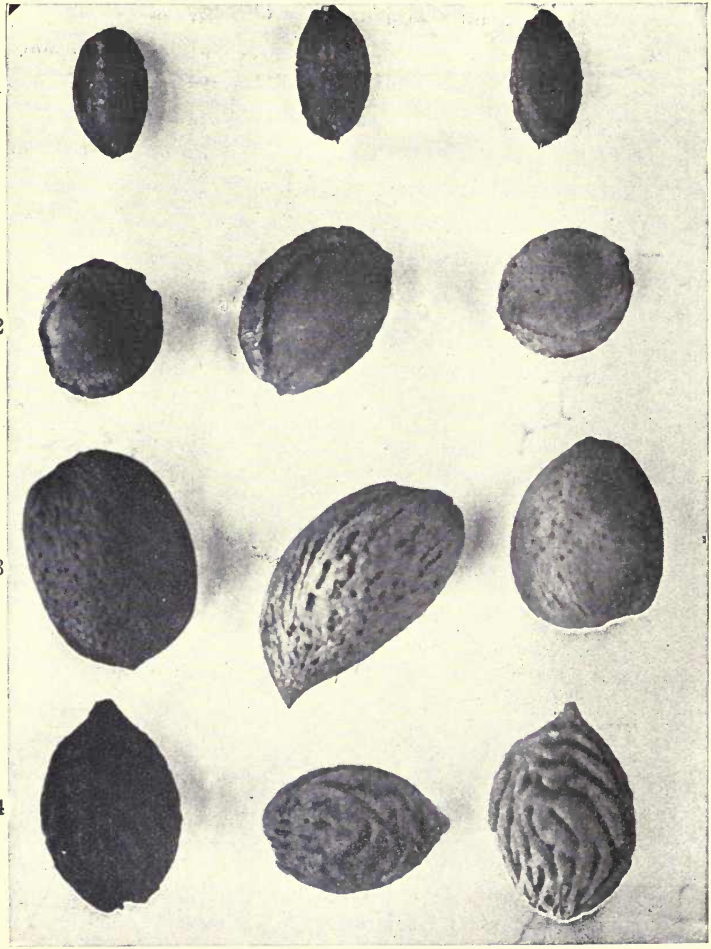


FIG. 2.—Some Common Fruit Seed. 1 Prune, 2 Apricot, 3 Almond, 4 Peach.

where the fruit is used for making a cheap wine. In the southern and western United States this variety is often referred to as the Cherry Plum, because of its resemblance to the common cherry. The tree grows well in the warmer climates and many nurserymen are now growing their own plum seed, Fig. 1. The Myrobalan does not do well in the colder parts of the prairie sections of the United States, hence some other kind must be substituted. Two kinds are available for this purpose, the Mariana and the St. Julian. Both are hardy and resistant to the cold dry atmosphere of the prairie winters. Some of the Japanese varieties of plums are grafted on to peach stock, but the practice is not general.

The seed for growing cherry stock is of two distinct kinds. This is necessary because the common commercial varieties represent two different species which are quite distinct in their growth and habits. The sweet cherries which are frequently referred to as the Hearts and Bigarreaus, are usually grafted on to the Black Mazzard, which is a wild type of the same species. The sour cherries or the Dukes and Morellos are worked on to the Mahaleb. Both of these stocks grow well in the United States, yet very few nurserymen attempt to grow them for their own use. For the most part they are imported from Europe by some nursery supply house and redistributed in this country. There are many wild species of cherries in the eastern part of the United States which may be used as stock for the standard varieties, but few nursery companies make use of them, simply because there has been no effort to collect them for the trade.

In the case of all the stone fruits, more or less difficulty is experienced in removing the fleshy covering in order to get the seed into suitable condition for handling or storage. With the Mahaleb and some types of the Myrobalan, the pulp is dried down on the pit and the seed is used in that condition. In most cases, however, the pulp must be removed. This may be done in either of two ways. One is to remove the flesh by hand, and then dry the pits in the sun. The other is to pile the fruit up in large piles and let them decay. After the pulp is fairly well rotted they are shovelled into a vat and soaked up with water. The souring or fermenting of the mass causes the pulp to become separated from the pits. They can then be separated by washing them over a wire screen. They are then dried in the sun, sacked up and stored in a cool moist place until needed.

For stock on which to work apples, nurserymen are pretty generally agreed on the use of the so-called French Crabapple. Strictly speaking these are not crabapples but simply the fruit of a wild apple of France. Many of the low foothills and poor land areas of France are covered with apples that have run wild, resembling somewhat in appearance the crabapple and somewhat our common apple. The French collect the fruit from these trees and, after extracting the juice for cider or vinegar, remove the seed from the pomace—thus the American "French Crab."

The stock grown from these French seeds are quite generally uniform in their habits of growth and make strong vigorous seedlings. They are sometimes imported

as seed but more often are grown for one year in Europe and then imported as seedlings. Nursery companies claim that they can buy the year-old seedlings cheaper than they can get the seed and grow them themselves. The seedlings thus grown are no better than American grown stock,—the situation simply represents an economic condition resulting from cheaper labor in Europe.

In recent years efforts have been made to grow apple seedlings in the United States. But few places have been found that will grow a smooth, clean plant with a straight root. The central west is now the chief center for growing these seedlings. Mr. D. S. Lake of the Shenandoah Nurseries, Iowa, makes the following statement on the subject:

"Nearly all the apple seedlings grown in the United States are in the vicinity of Topeka, Kansas, up and down the Kaw valley for thirty miles or more each way. This bottom land is made soil and more or less sandy but extremely fertile. There are about one thousand bushels of seed sown in the United States. Imported seed is mostly used and all the native seed used comes from Vermont, where there still remain some old seedling orchards. The improved cider mills crush the seed more or less and it is pretty hard to get good sound apple seed from Vermont. Sometimes half of the seeds are cracked by the mills, and when the hulls are once cracked there is no chance for the seed to grow. The French seeds are gathered from cider mills in sections where apples are grown for the cider only. They do not select choice varieties, but simply select and grow apples that produce the most cider. These apples are about the size of the seedling kinds grown in Vermont

and perhaps there are some similar orchards in other eastern states.

"The imported seed is strong in vitality and grow good seedlings, but the French seed is getting poorer than it used to be from the fact that instead of using the old mills that they used to, which did not injure the seed, they are gradually adopting the cylinder grinders like our own

FIG. 3.—Good Seed-bearing Trees Growing by the Roadside.

which crack the seed more or less and I do not think it will be a great while until even the French seed will be as inferior as the American apple seed is to-day. We figure in order to get one bushel of good seed we must buy two bushels. This was not the case years ago."

There are many varieties of apples in the United States yielding seed that will answer every requirement of good nursery stock. These have never been made use of com-

mercially, because of a lack of an organized effort on the part of any one to collect them for the trade. All through New England and in many of the other States apples grow wild in all sorts of places, Fig. 3. These often represent hardy, vigorous trees which bear fruit having plump, well-developed seed. There are also many of the commercial varieties

FIG. 4.—Skimming Off the Pomace.

which yield good viable seed. Even the common run of seed as taken from apple pomace can be used to good advantage if a little precaution is taken.

Gathering Apple Seed. To collect apple seed for nursery purposes it is necessary to get plump, well-developed seed from strong, vigorous, growing trees. The fruit is separated at harvesting time and the juice extracted for

cider or vinegar making. The pomace is then put into a barrel or tank and soaked with water. The little remaining sugar in the pomace gradually ferments, causing a thin slimy coat to form over the seed. The pomace is stirred thoroughly from time to time, causing the seed to separate from the pulp and settle to the bottom. After three or

FIG. 5.—Washing Out the Seed.

four days the pomace can be skimmed off the top of the barrel and the seed separated.

For separating the seed, two wire screens are needed, one of just large enough mesh to let the seed pass through and one small enough so they will not. Figs. 4 and 5. If, in addition, running water can be had the task will be easy. The large mesh screen will separate most of the pomace, while the smaller one will take out the smaller particles.

Then a little washing with the hose will leave the seed free from the pulp. They should then be spread thinly on trays in the sun to dry. When dried sufficiently to prevent molding they are sacked and stored in a cool moist place. Only heavy seeds, which are the good ones, will settle to the bottom. The poorer ones rising to the top are skimmed off with the pulp. In this way only good seeds are secured. Figures four and five will give an idea how this work may be done.

Pear seed is collected in the same way as apple seed. There is less use for cider or vinegar made from pears than from apples, yet they are often used commercially. Where it is not desirable to first remove the juice from the fruit, they can be piled up in the open and allowed to decay. After several days, fermentation will be sufficiently advanced so that the fruit may be treated in the same way as the apple pomace.

Nurserymen import most of the pear seed used for stock. The seeds from the Chinese or Japanese sand pear and the common French pear are the most used, being preferred for their resistance to the pear blight disease. Sometimes American grown seeds are used, in which case those of the Kieffer variety are preferred. This particular variety is a hybrid between the Chinese pear and the Bartlett, and partakes largely of its Oriental parent in its resistance to diseases. Other varieties are occasionally used, and in sections where the pear blight is not bad most any strong growing kind would answer.

For other tree fruits the customs are not so well fixed. In propagating the various kinds of nuts, numerous methods

are used. The English or Persian walnuts are either grafted on their own seedlings or on those of the Black Walnuts. The latter is preferred because of its hardiness and resistance to certain diseases. In the moist sections, the Eastern Black Walnut is used, while in the arid regions the Arizona Black or California Black are used because of their adaptability to the drier conditions. Pecans are worked on the more hardy native seedlings. Many of these

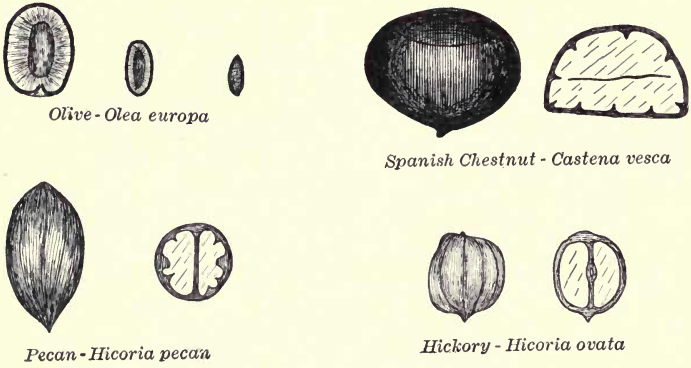


FIG. 6.—Some of the Less Common Tree Fruit Seed.

nuts are grown as seedlings, because only in recent years has any definite effort been made to develop better varieties, and the nearer any variety is to the native or wild condition the less the need for any special stock.

Chestnuts are usually worked upon the native American stock. Many of these are still grown as seedlings, there having been little effort toward improved strains. The hickories, butternuts, filberts and other wild nuts are almost entirely grown direct from seed, there being no need of

grafting. It is to be regretted that no greater effort has been put forth to improve some of our native nuts. They are widely variable, and in the hands of the right person could be developed into improved and highly desirable strains or varieties.

Sub-tropical Seeds. In the case of the tree fruits of the warmer climates no great choice of seeds exists. The citrus fruits (orange, lemon, pomelo, etc.), have quite a wide range of stock as they will readily interwork on the different species. The Florida sour stock, the seedling pomelo and the sweet orange comprise the bulk of the stock for all the different kinds of cirtus fruit. Formerly many lemons were used but these have since been discarded. They grow well, make a strong union but are not as hardy as the others. The Florida sour stock is preferred, and many propagators use it altogether.

The olive is sometimes grown from seed but more frequently from cuttings. The olive seeds are peculiar in that they have an oil sack surrounding the embryo which prevents moisture from getting in to start germination. Thus most olive seeds must have two years to germinate, making the process a long, tedious one. In Europe the hard seeds are cracked. But this is difficult as each seed has to be screwed up in a vise just enough to make a small crack. If overdone the germ is destroyed. However, they root fairly well from cuttings and do not have to be budded or grafted over.

Use of Cuttings. Some few tree fruits are grown from cuttings because the seed is either lacking or hard to grow. Of these the most important are figs and mulberries. Both

have very small seeds and in the case of the fig are very difficult to start,—in fact many of them are infertile. Olives and quinces are as frequently propagated from cuttings as from seed; and apples, pears and most of the citrus fruits may be grown in this way. The stone fruits are difficult to propagate vegetatively but can be so grown. The methods employed in growing trees from cuttings are quite different from seed propagation and will be discussed later.

Shipping Seed. As much of the fruit tree seed is gathered a long way from where it is to be used, some attention must be given to preparation for shipment. Most seed should be dry enough so it will not mold in bulk, yet not enough to lessen the germinating qualities. Most all of the nut fruits when thoroughly dried fail to grow. This is largely the reason why commercial nuts bought on the open market do not grow.

Small seeds like apple and pear may be mixed with powdered charcoal which acts as an equalizer of moisture. Larger seeds may be shipped in paper bags or cloth sacks anywhere on land, but if they are to cross the ocean they must be protected from salt air and excessive moisture. Oiled paper is used for small quantities, while boxes lined with some waterproofing material are used for large quantities.

Quantities Used. No carefully prepared statistics showing the quantities of fruit seed imported are available, but an average estimate from known sources would probably reach two hundred thousand dollars annually. Many nursery companies prefer to have the seed grown one year and then imported as seedlings. This method repre-

sents a saving because of cheap labor in most foreign countries. Importations of such seedlings, including cuttings, average eight hundred thousand dollars annually.

REVIEW QUESTIONS

1. Why do not most standard varieties of fruit " come true to seed "?
2. Who grows most of the nursery trees? Why?
3. Discuss the investments in nursery business.
4. Give a list of the tree fruits and the seeds used in growing stock for each.
5. Where is each different kind of seed collected?
6. What advantages have imported seed, if any?
7. Why are not American seeds more generally used?
8. Discuss the collecting of seeds for the stone fruits.
9. Give in detail the method of extracting apple seed.
10. Why is " French Crab " seed preferred for apples?
11. How does the handling of seeds for nut trees differ from the others?
12. What are the sub-tropical fruits and the seeds used for each?
13. Why are olive seed especially hard to germinate?
14. What fruits are usually propagated from cuttings? Why?
15. How are fruit seeds handled for shipment?

CHAPTER II

GROWING THE SEEDLINGS

Stratification. There are several methods employed in germinating the seed, depending upon the extent of the business and upon the convenience of the handler. They are sometimes planted directly into the nursery row and sometimes put through a sprouting process during the winter months in special seed beds, and then removed to the nursery in the spring. In the latter case several methods are employed. The usual one, however, is to bury the seed in a light sandy soil during fall or winter and then remove to the nursery row after sprouting has started. For the larger seeds, such as the peach and plum, a plot of ground is selected in the garden or some convenient place near where they are to be set in the nursery, and after levelling off, the seeds are spread out in a thin layer and then covered with from two to four inches of soil. In the prevailing climatic conditions of the south and west the seeds should be put into the bed during the months of November, December or January. The earlier in the winter they are put in the thicker should be the covering; the later the less the covering, so they will get the heat of the sun at about the same time. Some nurserymen prefer to spread the seed evenly over the top of the bed and then spade them in. This method often makes trouble in separating them when ready to plant.

Special Seed Beds. In the colder states where the winters are long and severe, seed beds are often used in place of the open ground. These are made in some sheltered place in the open or in some building if desired. Coarse sand is placed in the bottom to secure good drainage, then a layer of sand three or four inches deep on which the seeds are spread. These are then covered two or three inches deep with sand and allowed to remain through the winter. The seeds should be placed in these beds just before the ground freezes up for the winter (usually in November).

Care should be taken that the seed bed is placed where water will not stand on it during the winter lest the seed rot; also a light sandy loam is best, as the seeds are then easier to separate at planting time. There should be at least sufficient sand to prevent the soil from puddling and sticking to the seed. Several layers of seed and sand may be put together. This is often done by large companies to economize space. Under such conditions there is danger of the seed heating during the early stages of germination, and they should be shoveled over several times to avoid it. Such a process could best be handled indoors.

The seeds remain in these beds during the winter season where they absorb water and swell up sufficiently to crack the shell. When warm weather comes in the spring, sprouts begin to appear. During these early months the bed should be examined occasionally to determine the progress of germination. For the large seed, when the first sprouts appear they should be dug up, removed to the nursery and dropped from two to four inches apart in furrows prepared for them.

Lath Houses. If something more elaborate than the above described seed bed be desired, or if a permanent bed for use with other seed as well is wanted one can be made after the model of the accompanying illustration, Fig. 7. Such houses are constructed of lath at a nominal cost and if properly built and painted, serve as an ornament to any place. They can also be used for growing cuttings and other

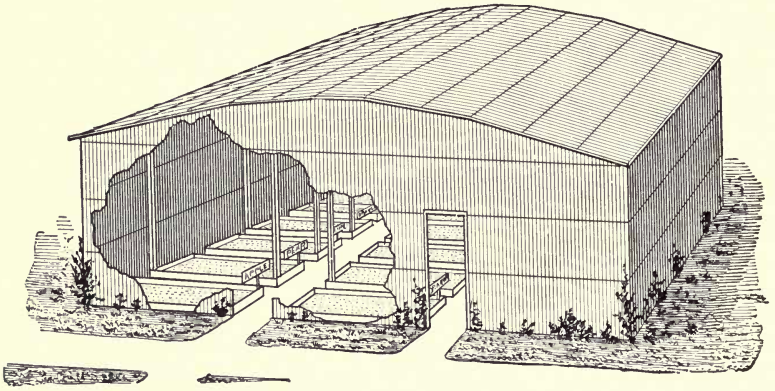


FIG. 7.—A Lath Propagating House.

seedlings, as well as a cool place for many ornamental plants during the heat of the summer.

Other Methods. Another method frequently employed is the use of sawdust or sphagnum moss. The seeds are thoroughly mixed with the sawdust or moss, shoveled into a barrel or box and set away in a damp place to sprout. This method requires greater care in keeping the right amount of moisture, but the results are quite as satisfactory. This does away with the use of any sand

and makes the seed more easy to move at planting time.

Handling Small Seed. Many nursery companies prefer to stratify the small seed in the nursery row rather than use seed beds. Apple, pear and quince seeds may be germinated in this way, but there is always the uncertainty of the number that will grow. Where the per cent that

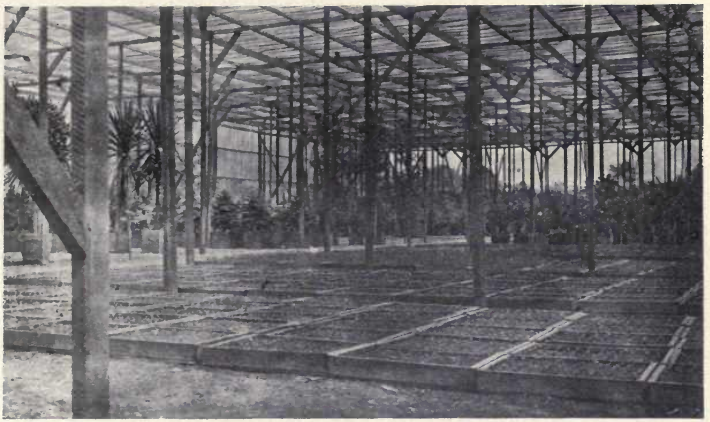


FIG. 8.—A Southern Propagating House.

will germinate is not known, the seed must either be put in very thick and then thinned out as they come up, or the gaps in the nursery row must be replanted in the spring. Another objection is that grass and weeds start as early in the spring as the seed and much fine work is necessary while the young plants are very small.

Use of Planters. A few companies claim success by this method with large seeds like peach, plum and apricot,

and no doubt the work is less expensive. Where the germinating power of the seed is fairly well known, this may be recommended. Under such conditions, the seed should be stratified for a short time early in the fall and then a special seed planter is used to drop the seed. This makes it necessary to buy the seed a year ahead of time since it is not

FIG. 9.—A Peach-seed Planter and its Inventor, J. W. Romine, of Monroe, Mich.

possible to collect them early enough to stratify and plant the same season.

The machines used to plant large seeds are of a special type, Fig. 9, and have given very good results wherever used. They drop two rows at once and have a capacity of about seventy-five bushels a day. The feed mechanism is adjustable and can be regulated at will. This is important be-

cause the poorer the seed the more will be needed to be planted to the foot. Where the seeds are stratified for several weeks before planting, the sprouting will have progress far enough so a mechanical test will give a fair estimate of the per cent that will germinate. This test is made by selecting at random one hundred seeds, splitting open the shell and examining the kernel. Those that are sound, plump and in good condition can be depended upon to grow. From these figures the per cent is calculated and the feed of the machine adjusted to give just the right number of good seeds to the foot of row.

Large commercial companies which make a practice of growing seedlings for the trade use the nursery row method altogether, as it is much more economical. The bulk of American grown apple seedlings are produced in Iowa and Kansas, where over eight hundred acres are annually devoted to this purpose. Mr. F. W. Watson of Topeka, Kan., gives the following method for growing apple seedlings on a large scale:

"The bulk of the seed comes from France, packed in charcoal. As soon as received, it is run through a fanning mill to take out the charcoal, then put in sacks and soaked from five to seven days, the water being changed several times. It is then stored away in a cool place, until planting time. If the weather happens to be cold so the seed can be frozen before planting time, so much the better. Seed that has been planted without having first been well soaked starts irregularly and often a large proportion will not sprout. At planting time the seed is spread out on long screens to partially dry so that it will pass through

FIG. 10.—Fifty Acres of Apple Seedlings.

the drills freely. If the sun is hot and the seed becomes too dry, it will germinate slowly and sometimes it will fail to start at all and the crop is lost. As soon as the seed begins to sprout the cultivators are started.

" The drill used to sow the seed is a wheat drill remodelled so as to sow four rows twenty-four inches apart, planting the seed three-quarters of an inch below the surface and covering with a ridge three inches high."

" From eight to twelve good seeds are planted to the foot, from one to one and a half bushels to the acre."

Large vs. Small Seed. Large seeds including most of the nuts and many of the stone fruits are very easy to handle through the seed beds and for small quantities this method is preferable. As the sprouts appear in the spring they are large and strong and can be moved with little danger of breaking. They will not all germinate at the same time and those that show no signs of swelling in the spring should be discarded. They are easy to separate from the sand in the seed bed, and should be dropped into a furrow in the nursery row from one to four inches apart according to what the future treatment is to be. No attention need be given to the position of the sprouts when planted.

Small seeds like apples and pears will often germinate very early and may blight before the planter is aware. They will need to be moved very early to the nursery row or covered with more soil, shaded from the sun and allowed to grow in the seed bed. After the second pair of leaves appears they can be dug out and transferred to the nursery the same as any seedling. This process involves the hand-

ling of each plant individually, and where large numbers are grown makes the process very expensive, although excellent results can be obtained in this manner.

Shading. Where seeds are allowed to grow in the beds the little plantlets may be very sensitive to sunlight and will need to be protected. If the lath house previously referred to is used, this will be sufficient. Posts may be dug in along the beds and covered with lath, or white muslin may be stretched over the beds. If these are three or four feet above the ground results will be better. The farther south the nursery is located the more important the shading becomes.

Summer Planting. Practically all fruit seed will germinate if planted during the summer, and for the small home nursery spring or summer planting may sometimes be desirable. Growth is not so rapid and this method often calls for an extra year in the nursery. The one difficulty of this plan is to keep the seed in good condition over the winter. They should be kept cool and moist and not exposed to rapid changes or extremes of temperature.

Freezing Fruit Seed. The idea common in many places that hard shelled seeds must be frozen before they will germinate is quite erroneous. Often, freezing may hasten germination but is in no case necessary. Where cold is made use of in practice, the seeds should be covered with soil to prevent a too rapid fluctuation in temperature. If exposed to frost in the open air germination will be retarded, and if too severe will be prevented altogether. All kinds of hard-shelled seeds may be germinated readily in the greenhouse where no signs of frost have been.

Soaking Fruit Seed. Frequently germination may be hastened by soaking the seed in warm water for some time before planting. It is a process, however, not generally practiced except with imported seed, as it is attended with some risk. Where soaking is done the water ought to be kept near one hundred degrees Fahrenheit, and changed at least once each day. If the water is allowed to become stagnant, the seeds may be coated with a slime mold resulting in a rapid deterioration of germinating power. Twenty-four to forty-eight hours is usually enough for the smaller seed, while the large seed may be soaked from three to ten days. When removed from the water they should be planted immediately and not allowed to shrivel. Olive seed are sometimes helped in germinating by soaking for two days in a four per cent solution of caustic potash.

Cracking Hard Seed. Most hard seeds may be cracked before planting to hasten germination. The embryo should not be removed from the shell but a crack made just large enough to allow moisture to enter. Many hard-shelled seeds require months to absorb sufficient moisture to force open the shell. The hammer should not be used to crack the seed, but a small vise in which each one may be tightened just enough to start an opening.

Testing Seed. Much has been said about testing fruit seed before planting. The prevailing opinion among the best nursery growers is that the practice is not worth while. So many conditions enter in, so much time must be consumed in making the test, that results have seldom been satisfactory. Germinating tests made in greenhouses or hot beds in the winter never correspond to the

results in the open ground, so are of little value as a guide.

In buying seed for nursery work one should make every effort to get those of the current year's growth, and then by applying a number of mechanical tests a fairly accurate forecast can be made. Several seeds should be opened and the kernels examined with a lense. If it is plump, well developed, the surface showing few wrinkles and the embryo fresh, one can be reasonably sure of good seed. Good kernels of the stone fruits should not show a gummed condition.

Viability of Fruit Seed. No very accurate experiments are available to show just how long seeds may be kept and still germinate. One can be reasonably sure that all the larger seeds when once thoroughly dried out will never germinate. When kept under best known conditions they may hold their vitality for a long time; in some cases as long as ten or fifteen years.

Many nurserymen have commented upon the fact that the germinating qualities are widely variable from year to year. The year the seed is collected the per cent of germination should be high; the second year low; the third year high again and so on; the alternate years being either high or low in the per cent germinating. In the writer's own experience peach seeds have been known to germinate eighty-five per cent the first year, ten per cent the second, seventy-five the third; all from the same seed crop. These seeds were kept in a bag on an earthen floor in a damp but not wet cellar.

REVIEW QUESTIONS

1. What is stratification? Why necessary?
2. Give the different methods of stratifying seed.
3. Which ones are adapted to large nurseries and which to the use of the orchardist?
4. Where are seed beds used? How made?
5. When may lath houses be desirable?
6. What fruit seed may be planted direct to the nursery row?
7. When may seed planters be used? How do they work?
8. Give method of handling apple seed on a large scale.
9. Give details for handling large seed when planters are used.
10. How are small seeds germinated when only a few are wanted?
11. How are seedlings handled when allowed to grow in the seed bed?
12. Discuss the value of shading for seed beds.
13. How do fruit seeds behave when planted in the summer?
14. Discuss the necessity of freezing hard seed.
15. Discuss the value of soaking hard seed.
16. What are the effects of cracking fruit seed?
17. How are fruit seeds tested?
18. Discuss the viability of fruit seed.

CHAPTER III

THE NURSERY

General Considerations. The work of producing nursery stock is usually considered as a business independent of that of fruit growing, and in most cases is justly so treated. The handling of a large nursery requires as much skill and business ability as the handling of any other enterprise. The novice or small fruit grower is usually no better qualified to grow his own nursery stock than he would be to make his own machinery. On the other hand some knowledge of the principles of the business is essential even though the hands have not been trained in the details.

Most nurseries have their limitations due to the various economic principles involved, and to the ability of the management; and it has frequently happened that an individual grower having some knowledge of the business and a large amount of enthusiasm, often produces better results than the nurseryman. Such people should grow their own stock, but the average fruit grower having but a few acres of orchard along with general farming can usually do better by buying nursery stock of some reliable company. There are, however, in every fruit-growing section orchardists who devote their major efforts to the production of fruits, and find it to their advantage to grow their own stock.

It is no longer easy to start a nursery business on a

large scale, hence the beginner will need to investigate carefully before locating his place. The opportunities are still great but it is constantly requiring more and more skill for the manager of a nursery company to be successful. Competition is getting greater every year and the margin of profit for most of the plants grown is gradually getting smaller. The amount of capital invested is increasing from year to year, and while it is possible for any one to start a nursery on a limited capital, it is almost imperative that good, strong financial backing, to the extent of several thousand dollars, be had before one can be assured of success.

Points on Location. The individual looking for a place to locate a general nursery will need to consider the following conditions: First, he must have climatic conditions which will be suitable for the growing of a large variety of nursery stock. Second, that few companies are able to grow all of their stock in any one location, some of them being spread over a half dozen states. Third, he should give careful attention to soil conditions. Nurseries located on side hill or rolling land are not usually favorable to best results. More or less level land is necessary and that which is easily workable throughout the greater part of the year. The soil ought to be deep, well drained, with a strong rich sub-soil easy to maintain in fertility requirements. Fourth, shipping conveniences, railroad facilities, etc., should always be considered. As much of the stock has to be shipped long distances, the better the location for shipping facilities, the more favorable will be the prospects. Fifth, he should give considerable attention

to the surrounding environments. Our best nurseries are located in the best fruit producing sections, and usually in those which are the most progressive. It is not the purpose of the nurserymen to educate the people to buy certain kinds of stock, but simply to grow and furnish the people what they want, hence a location in a poor fruit-producing section would be contrary to the first principles of economics. We therefore find, that our largest and best nursery companies are located in the chief centers of production, and usually in the most progressive and desirable points in those centers. Accordingly the financial returns and the success of the business follows as a sequent.

The bulk of the capital invested in nurseries lies in the central or more thickly populated parts of the United States. This is largely because the demand of the surrounding territories calls for their particular kind of fruit; also, partly to the fact that nursery companies located farther south or north could not supply all the different kinds of materials required by the orchardists.

Small Nursery Plats. Anyone contemplating going into the nursery business as a special line or on a large scale would find it advisable to take an apprenticeship course with some of the larger companies. There are plenty of opportunities for learning the ways of big nurseries through the numerous companies now in existence. The only requisite for such an apprenticeship is a willingness to work and a strong desire to know how things are done. Nurserymen are always willing to have such men around, and the willingness of the companies to retain such

men on their pay roll can be taken as a fair indication of the ability of the individual to branch out in the work for himself.

It is always possible for the individual to get into the work on a small scale and grow as his ability and capital warrants. It is true that most of our large companies started in this way, and while times and conditions have changed some opportunities are still left.

It would seem best in this connection to discuss more in detail the various operations applicable to the small nursery for the benefit of those who may wish to go into the work as a side line of general horticulture, or for those who are just starting a nursery for the first time. It is quite generally recommended that every orchardist or horticulturist grow some nursery stock in connection with his business even though it be only for experimental purposes. Not only would he grow the fruits which are standard for the purpose of maintaining his orchard but also there should be a place for experimenting with new varieties, novelties, etc. The beginner, under such conditions will not need to pay so much attention to the general environments or surroundings as the one who is in the business on a large scale, but he will need to give considerable thought to the selection of his plat for the various nursery operations, and should also understand the details of all the general practices.

Nursery Site. In many cases the beginner will be handicapped because of the lack of suitable conditions under which to start his nursery. However, the area needed is not large and almost every fruit farm will con-

tain some small place that can be used. Among the things to look for and consider might be mentioned the following: The condition of the soil, ease of drainage or irrigation, protection from winds or snow in the winter, convenience in handling the work and protection from the various domestic animals which may be kept on the place.

Soil Requirements. On almost every fruit farm there is some place where the soil conditions ought to be satisfactory. The best soil would be a medium sandy loam with a depth of three or four feet for deep root penetration. If the under soil is too hard, the roots of the seedlings will branch too much and become crooked. If it is too loose it will be hard to maintain fertility and get the proper growth. A little clay mixed with the under soil sufficient to get a branching root system would be ideal. The top soil should contain enough sand so that it will be easily workable and will not puddle after rains or storms. If the surface soil is heavy enough to form a crust after each rain, it will be difficult to give sufficient cultivation, and also the young seedlings will have trouble in pushing through to the surface. A garden loam which is in good cultivation and well cared for would do well for a small nursery plat. Many streams or creeks have places along their courses with unusually rich soil which will make ideal conditions for nursery trees. Such places should of course be above the high water mark.

Drainage. The nursery plat should be well drained. Water should not stand over the surface during the winter and the subsoil ought to drain off readily in the spring down to a depth of at least three feet. This is necessary to se-

cure good root action in the spring. If water stands above this level the roots will not penetrate into it. Where conditions are such that a dry season occurring during the summer or fall is liable to affect the growth of the seedlings, then if irrigation could be provided for, so much the better. In the eastern and northern states the so-called "Skinner System," Fig. 11, of irrigation has been found to be highly

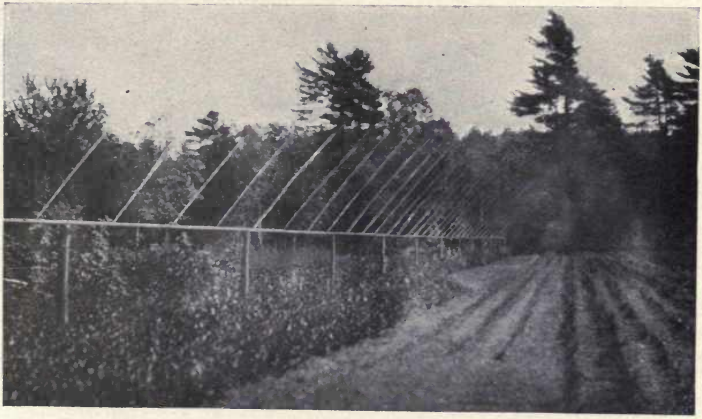


FIG. 11.—The Skinner System of Irrigation.

efficient in helping to produce good growth. In the south and west, the ordinary methods of irrigation where ditches are used to convey the water between the rows is the common practice.

Protection from Wind and Snow. In the northern or colder part of the United States, some thought should be given to protection for the nursery plat during the winter months. A few large trees along one side of the

nursery or other natural protections such as buildings, low hills or woodlots is desirable. The protected side of a good orchard would be sufficient in most cases. Such protected places are frequently troubled by the accumulation of large drifts of snow. Wherever the velocity of the wind is checked the snow tends to pile up. Such conditions should be guarded against by leaving about fifty

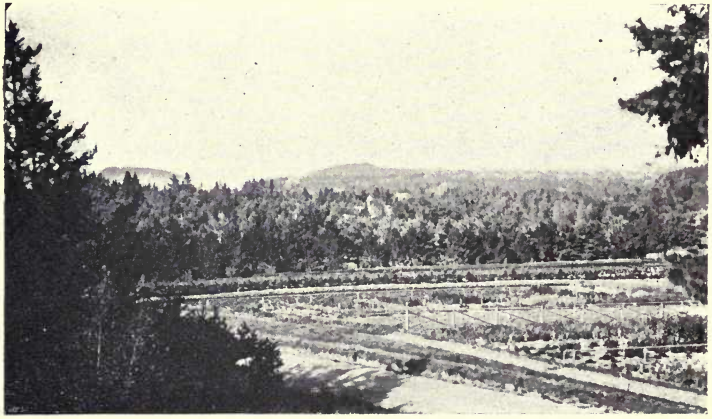


FIG. 12.—A Maine Nursery with Good Natural Protection.

feet of open space between the barrier and the first of the nursery planting. Every orchardist should be familiar enough with his own place to know where such drifts accumulate and where open though protected places can be found.

Protection from Animals. The nursery should be well protected against the intrusion of any domestic animals which may be kept in the vicinity of the plat. Small

nurseries can be damaged beyond repair in a very short time by the intrusion of one horse or cow, and this often discourages the orchardist to attempt any serious operations. Interest can be maintained only where conditions can be controlled. High wire fences built to keep out all intruders (even poultry) are essential to the success of the small nursery. If, in addition to the above, the plat could be located near the residence more interest would be taken.

Size of the Plat. This will depend entirely upon circumstances. The average orchardist who may have thirty or forty acres of fruit will need only a very small tract. One acre in nursery trees will run from five thousand to eight thousand plants. Ordinarily a small piece of land thirty or forty feet wide and fifty long will accommodate a large number of nursery trees. If the intention is to grow some for sale, the size could be increased to suit the needs of the individual. The beginner often makes the mistake of attempting too large a tract for his first efforts.

Preparation of the Plat. For best results this ought to be done in the fall. A good coat of barnyard manure or compost should be applied late in the fall and plowed under, turning the furrows to a depth of eight or nine inches. If the sub-soil is inclined to be hard the use of a sub-soiler will help materially. The ground should be levelled off, smoothed down and any uneven places filled up. If the plot has been neglected for several years and grown up to grasses that are hard to eradicate or is full of foul weeds, one season's summer-fallow would be advisable. Good nursery trees can only be grown where

the best culture is given and numerous weeds always add to the expense and difficulty of cultivation.

The rows should be laid out the long way so as to make use of horse cultivation wherever possible. If too much is left for handwork, the probabilities are that it will be neglected; and many efforts have failed purely because too little was done by team work and too much left for the hands. If the plat could be so arranged that the rows might run one hundred feet in length, even though they were only four or five rows wide, the results would be better in the end.

Planting. The work of planting the seeds will depend entirely on whether the seeds are stratified in seed beds or whether planted direct to the nursery row. With apple, pear and quince seed, better results could probably be had by planting direct to the nursery row in the spring. If the seed is clean, a furrow should be made about three inches deep and the seeds scattered along in these and covered up, leaving a little ridge two or three inches high where the row was. The larger seeds where stratified in the seed bed should be moved to similar rows early in the spring. Or they may be left to come up in the seed bed and transplanted to the nursery row after the second pair of leaves appear. In such cases they would be planted three or four inches apart in the row. The rows should be sufficiently wide, three feet is the common width, to permit the use of horse cultivators.

Setting out Imported Seedlings. If the seedlings are purchased from other sources and are grown simply for the purpose of budding or grafting, then the planting should be

changed slightly. A furrow six or eight inches deep is made by a special plow, Fig. 13, or may be dug by hand. The roots of the seedlings are cut back leaving five or six inches below the ground line. These are then set in the furrows about six inches apart and the soil pulled in and pressed around the roots. A dibber or small hand hoe is used for this pur-

Fig. 13.—A Trencher for Making Furrows for Seedlings.

pose. A cultivator with a special attachment for filling the remainder of the ditch and firming the soil around the roots is then run over the rows, which completes the process. This same method is also used in setting out apple root grafts in the spring. The customary practice is to root graft the apple before planting and set pears as seedlings to be budded through the summer. The setting

out process is essentially the same except that the grafts must be handled with more care. Where apples are budded the treatment would be the same as for pears.

If only a few seedlings are to be planted the dibble and a line to get straight rows, would be sufficient. If the ground is in good, mellow condition the work can be

FIG. 14.—A Firmer Used in Packing the Soil Around the Planted Seedlings.

done quite rapidly. The operator crawls along the line on his knees, makes the holes and sets the plants as he goes.

Cultural Methods. As soon as the seeds begin to sprout in the spring or growth starts on the seedlings, cultivation should commence. Where ridges were left over the seed-rows, these should be raked off very carefully, Fig. 15,

FIG. 15.—Sliding off the Ridges over the Seed, just before Growth Starts.

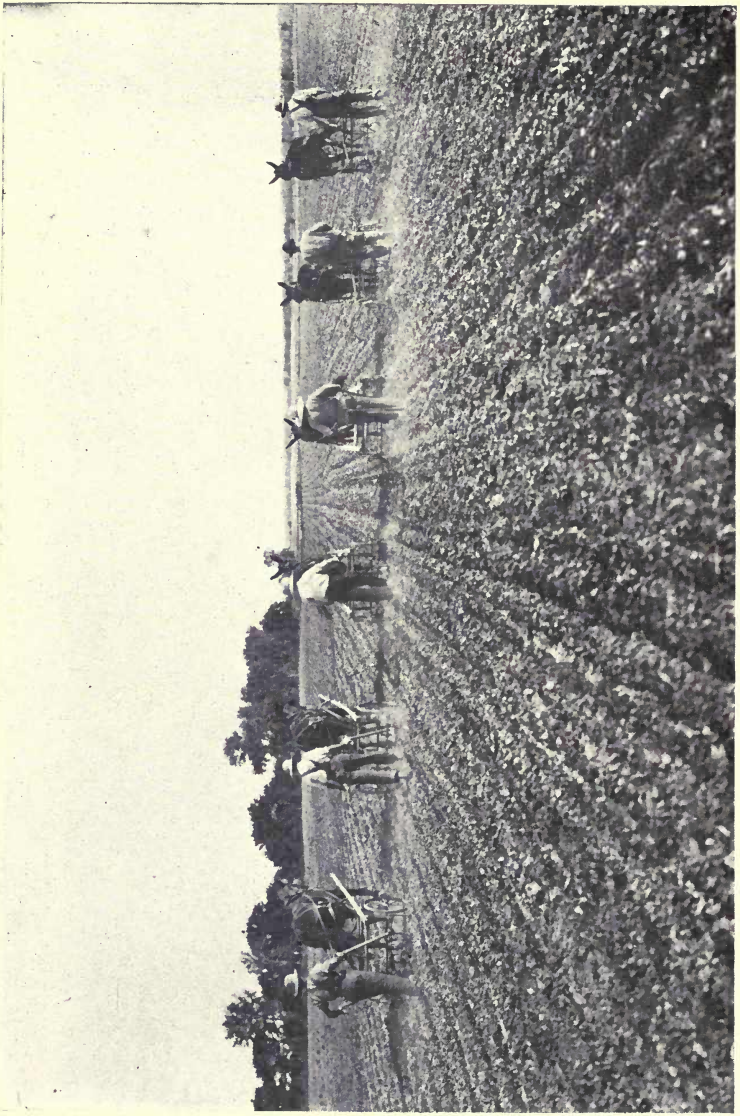


FIG. 16.—Cultivating the Seedlings.

the object being to remove the weeds, grass, etc., which may be growing on the row, and also give the little seedlings a better chance to get through to the surface. From this time on clean culture should be given; all weeds in the row kept out by hand hoeing and the soil stirred with a horse

FIG. 17.—Firming the Ground after Cultivating.

cultivator once every week or ten days throughout the season. As about one-third of the average nursery is in seedlings considerable hand labor is necessary.

If the soil is deficient in fertility the addition of compost or commercial fertilizers may be necessary. If there is not sufficient rainfall to maintain a good growth through-

out the season, the addition of water may be required. The seedlings should make a steady growth and not be checked for the lack of moisture.

Spraying. It will hardly be possible to grow good seedlings without suffering from the effects of insects or fungus diseases. It is usually necessary to spray nursery stock from one to three times during the growing season. Early in the season bordeaux mixture or lime sulphur can be used, and later, if necessary, arsenate of lead may be included with the others. The same strength of sprays is used as for older trees. Often the apple aphis will appear and in such cases they should be sprayed with tobacco extract. If the spraying is carefully attended to, the seedlings should grow to a height of from two to three feet the first year, and have a diameter sufficient to either bud or graft as the case may be.

Fall Treatment of Seedlings. If the seedlings are grown to sell as such, they are dug up in the fall and given a special treatment. Where they are to be used for propagation, only those that are to be grafted are dug, the others remaining as they are until ready to be used as a nursery tree. The apple is the only fruit that is root-grafted to any considerable extent, and the fall treatment for such seedlings is best described by F. W. Watson of Topeka, Kansas, who says:

"We use a digger similar to a tree digger, excepting in width; it is only ten inches wide. Seedlings are cut at a depth of sixteen inches. The pullers follow the digger closely, pulling, bunching, tying and burying the seedlings in a deep furrow in the field, Fig. 18. Only a few minutes

elapse between the time the digger passes under the seedlings until they are pulled, buried and covered, tops and all. If the pullers do not follow closely to the digger, and the seedlings should stand for an hour or so in the hot sun or a high wind after cutting, they will become

FIG. 18.—Burying Apple Seedlings to Remove Leaves.

soft and willowy, with a tendency to die back at the tip, showing their loss of vitality.

" After seedlings have been buried in the field for fifteen or twenty days, the leaves begin to drop off, and it is then safe to take them up and haul them to the grading cellar. Here they are buried in beds in a convenient place near to where they are to be graded. In these beds the bunches stand upright, they are wet when put in, and covered with

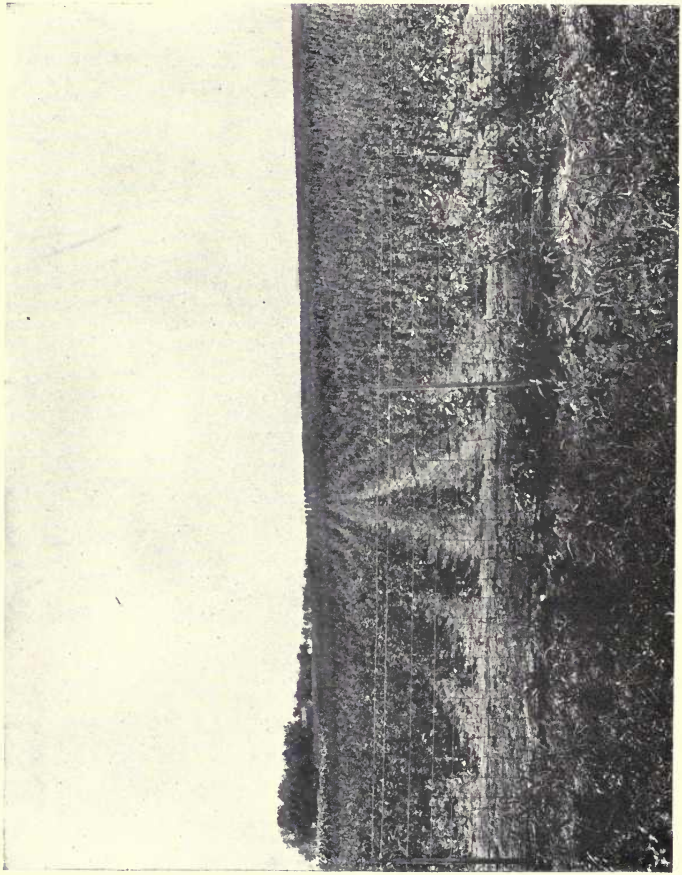


FIG. 19.—Field of Apple Seedlings.

dirt until only an occasional top is exposed, then a cover of manure or leaves is spread and they are left in this way for several weeks in order to sweat the balance of the leaves off before grading. Here is our last danger point—if a heavy rain or a late warm spell should come, the bed

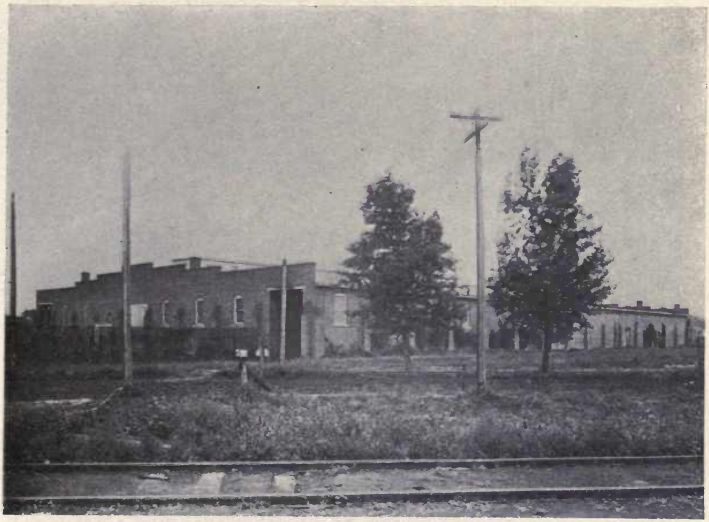


FIG. 20.—Storage Cellar in which Apple Seedlings are Handled.

is liable to heat and the entire crop may burn up. There is no sure preventive against burning, but by using a liberal quantity of dirt between the layers when the seedlings are trenched-in the liability may be lessened.

" Grading begins about December the first, in cellars (Fig. 20) built for this purpose. Seedlings are hauled in from the beds, run over the ' Shaker ' to get out the leaves and dirt

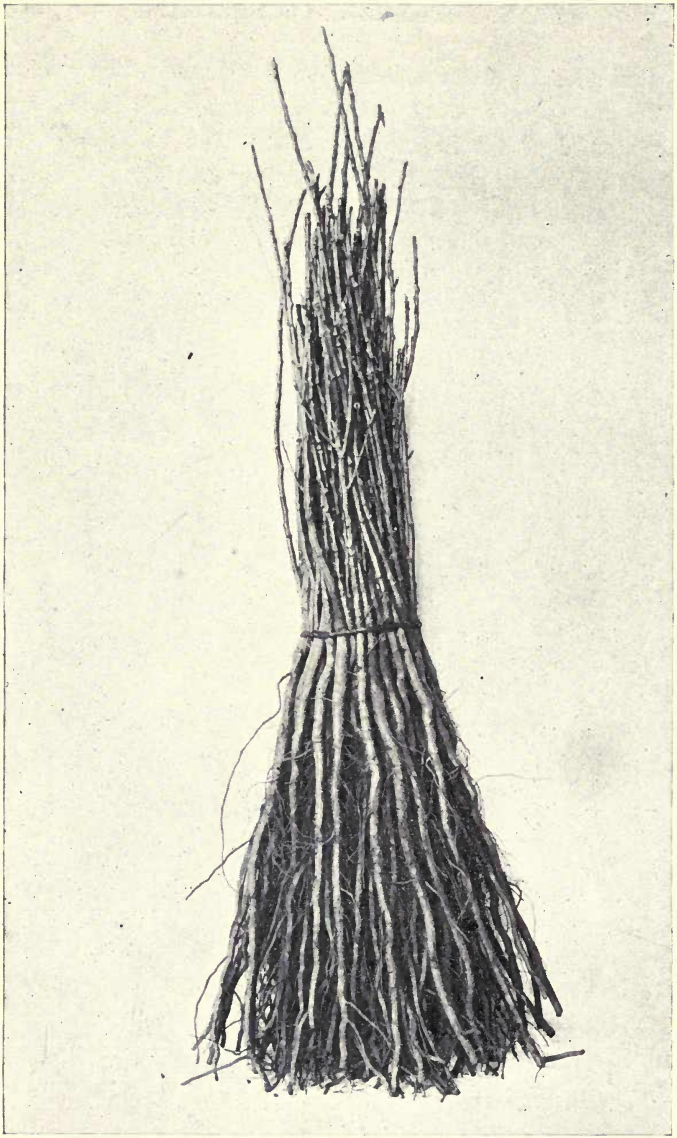


FIG. 21.—Apple Seedlings. No. 1 Straight.

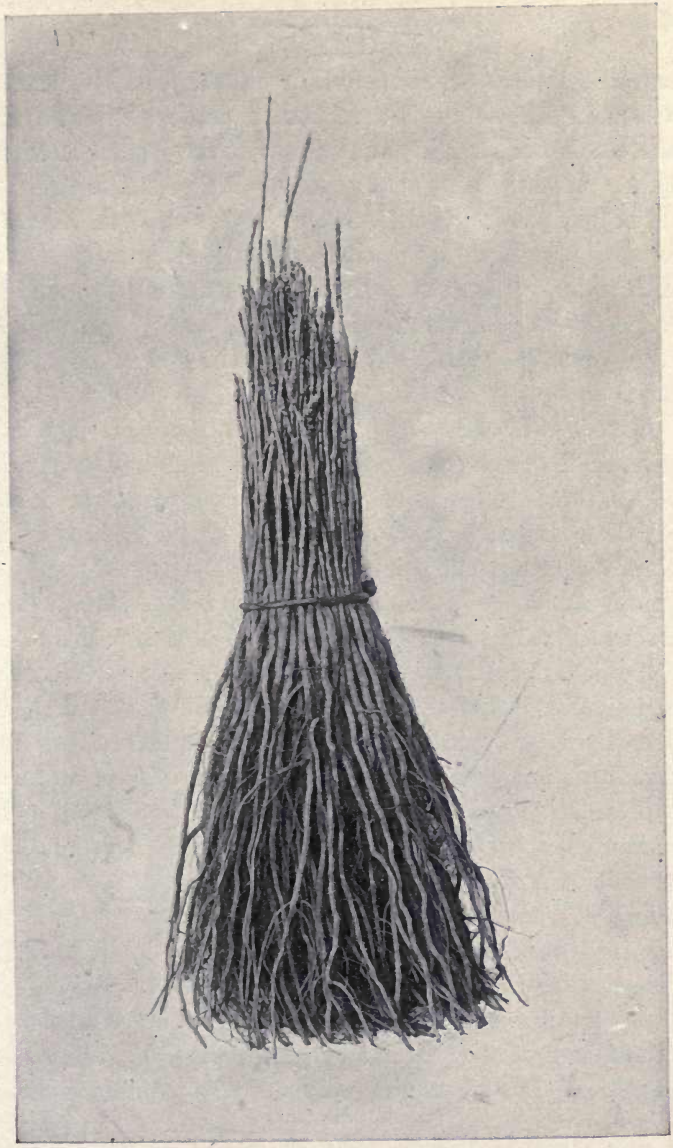


FIG. 22.—Apple Seedlings, No. 2 Straight.

from the bunches, and placed upon the benches, where each man takes out his particular grade. Several will take out No. 1 straight, and pile what are left on another bench. Here the next grade, No. 1 branched, are separated, and so on, passing from bench to bench until all the different grades have been taken out. Each man continues on the same grade during the grading season. As soon as graded the seedlings are tied in bunches and go through a trap door to the storage cellars, where the packing and shipping is done.

Grades of Seedlings. "An ideal No. 1 straight (Fig. 21) apple seedling is one that is fourteen to sixteen inches long, is at least three-sixteenths of an inch in diameter at the collar and three-sixteenths of an inch in diameter seven inches below the collar, and continued straight between the two points. An ideal No. 2 seedling (Fig. 22) is one that is twelve inches long, is at least two-sixteenths of an inch in diameter at the collar and is two-sixteenths of an inch in diameter seven inches below the collar and continues straight between these two points. An ideal No. 1 branched seedling (Fig. 23) is one that is at least three-sixteenths of an inch in diameter at the collar and has three or more roots, well distributed, not exceeding three and one-half inches below the collar. A No. 3 seedling is one that is two-sixteenths of an inch in diameter at the collar but fails to carry its diameter of two-sixteenths far enough down to grade No. 2; it is sometimes branched.

"A peculiar thing about the growing of apple seedlings is the fact that they cannot be grown with profit in small quantities. If a firm uses only 100,000 to 300,000 in a

season, it is economical to buy rather than to grow them. There is no profit ordinarily in growing as small a lot as

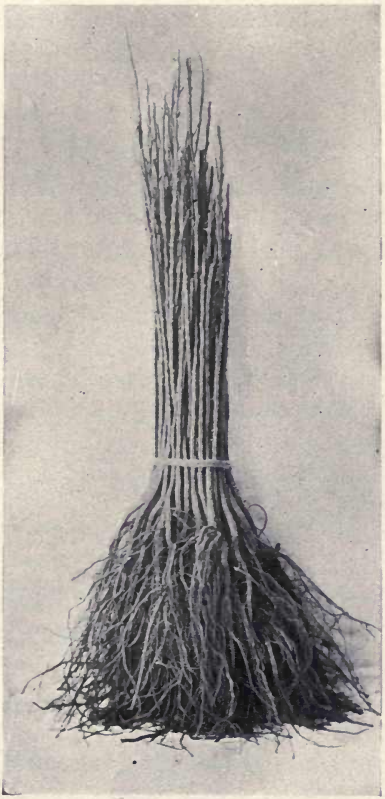


FIG. 23.—Apple Seedlings, No. 1 Branched.

five acres. This condition arises from the fact that to properly handle the seedlings it takes special tools, drills,

cultivators, diggers, cellars, all expensive equipment that can be used for no other purpose.

"The result is that the growing of all the twenty to forty millions of American grown apple seedlings that are used in this country every year is undertaken by less than a dozen firms."

REVIEW QUESTIONS

1. What are the present-day opportunities to develop a large nursery business and what should the beginner do?
2. What are the essential cousiderations in choosing a nursery site?
3. What place should the small nursery occupy in connection with orcharding?
4. Discuss the soil requirements for the small nursery plat.
5. What should be the practice in regard to irrigation and drainage?
6. Discuss the importance of protection of the plat from wind, snow, animals, etc.
7. How much land would the beginner or the orchardist need for nursery work?
8. What is necessary in the preparation of the plat?
9. How would the seed be handled for the small plat?
10. How are imported seedlings handled?
11. What treatment is necessary in the summer culture of the plat?
12. Discuss spraying in connection with the growing of seedlings.
13. What is the usual fall treatment for seedlings?
14. How are apple seedlings handled on a large scale?
15. What are the standard grades for apple seedlings?

CHAPTER IV

THE DIFFERENT BUDDING OPERATIONS

Budding or Grafting. In working over nursery stock to standard varieties two methods are available: One to graft, the other to bud. These two methods do not differ widely in principle but the details of execution are materially unlike. In the first place the process of budding is always associated with the active growing plant while grafting must be done while the trees are dormant. In the former, a single bud with some of the closely surrounding bark tissue is used to start the new tree while in the latter two or more buds with their connecting internodes are used. In grafting, the piece bearing the buds is called the cion while the plant into which it is set is called the stock.

Whether nurserymen should bud or graft the major part of their stock would depend upon the ease and economy with which the work could be done rather than upon any scientific principles involved. Either method will produce equally good trees. The cost of production, however, varies widely and as would be expected the practice among nurserymen throughout the United States is the outgrowth of certain economic conditions made necessary in the adjusting of their work to local environments.

Certain practices have become quite generally established over a considerable part of the country, while others

due to peculiar climatic conditions or to the length of the growing season are widely variable. It is the practice among nursery companies of the southern and western states to bud practically all of the stone fruits while the apple and in some cases the pear and the various nuts are grafted. In the central states the apple is the chief fruit grafted, all others being more easily budded. In the colder parts of the United States the practice is to bud almost everything. The only wide difference between the eastern and western states is the method used on the nut fruits. In the more arid regions of the west grafting is preferred, while in the humid conditions of the south and east budding is the usual practice.

Most growers agree that the budding operations are cheaper and come at a time of the year when it is easier to do the work, also some time is saved in the number of years required to grow good nursery trees. The stone fruits make a very rapid growth, are relatively short-lived and adaptable to a wide area. The pome fruits grow more slowly, and more care and expense is necessary to produce a first-class nursery tree. The various citrus fruits are still more difficult to grow and can only be handled successfully in a few of the warmer places of the United States. The hardest of all nursery trees to grow are the nut fruits. This is in part due to the fact that nuts have not been propagated for a very long time and the best methods of handling them have not been worked out.

The Prevailing Practice. If any general classification of the modern methods of nursery propagation were possible, the following would represent a fair average condition:

Fruit	Budding	Grafting	Cuttings
Almonds	*	†	‡
Apricots	*	†	‡
Apples	†	*	§
Avocadros	*	†	§
Cherries	*	†	‡
Dates	‡	‡	*
Figs	†	†	*
Grapes	§	†	*
Kumquats	*	†	†
Lemons	*	†	†
Limes	*	†	†
Loquats	*	†	†
Mandarins	*	†	†
Mangos	*	†	†
Mulberries	†	†	*
Oranges	*	†	†
Olives	†	†	*
Peaches	*	†	‡
Pears	†	†	§
Pecans	*	†	‡
Plums	*	†	‡
Persimmons	*	†	‡
Pomelos	*	†	§
Prunes	*	†	‡
Quinces	†	†	*
Walnuts	†	†	‡

* The usual method. § Occasionally used.
† May be used. ‡ Not practicable.

The Budding Operations. The process of budding consists of cutting a dormant bud from a tree which grows the desired fruit and inserting it under the bark of the tree on which it is to be grown. There are many points to consider in the handling of the buds and in the selecting of the best kinds. Considerable skill is necessary in the cutting of the bud as well as in the process of setting

and tying. The work is done in the nursery row and can best be handled by two people; one to cut and place the buds, and one to follow with the tying. The various steps in the process of budding may be classified as follows:

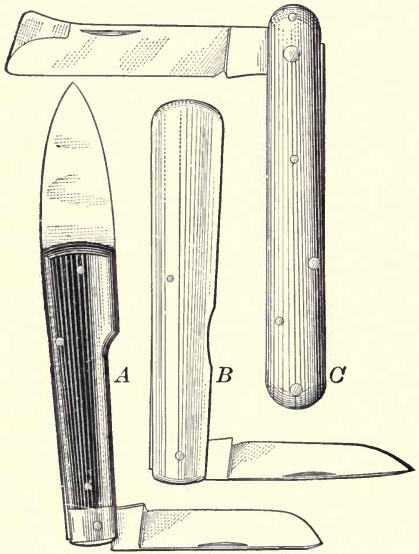


Fig. 24.—Standard Types of Budding Knives.

1. Stripping the seedlings.
2. Cutting the buds.
3. Inserting the bud.
4. Tying up.
5. Loosening the ties.
6. Cutting back.
7. Sprouting.

Tools for Budding. Very few tools are required for the work of budding. The essentials are a good sharp knife and some material for tying the buds. There are numerous

makes of knives on the market, but any one of the three shown in the accompanying illustration (Fig. 24) will answer. *A* and *B* are the common ones while *C*, an imported one, may be used for both budding and grafting. For the wrapping, two different materials are available; a soft cotton

FIG. 25.—Peach Seedlings, the Right Size for Stripping.

string and raffia. The latter is a fiber from one of the fan palms and makes a very desirable tie. The strands are thin and flat, making it easy to cover the bud.

Stripping the Seedlings. The first process in the actual work of budding is to "strip" the young seedlings. This is done by removing the leaves from the first three or four inches next to the ground, about the time

the seedling reaches the height of eight or ten inches. The object of this is to have a clear, smooth place for the budder to work. If the bottom leaves are not removed they soon develop into small branches which by fall, often seriously interfere with the budding process. The stripping is accomplished in the manner illustrated in the accompanying picture, Fig. 26. The tree is held by the left hand while the

FIG. 26.—Stripping the Young Seedlings.

thumb and two first fingers are slid down to the bottom, removing the lower leaves at one stroke. The scars left by the leaves heal over in a few weeks and by the time the young trees have attained a diameter of one-quarter inch they are ready for the budder.

Kinds of Budding. There are many different names applied to the various budding operations, but four have become more or less general and are here accepted as the

ones best suited to the different processes. These may be listed as: June Budding, Dormant Budding, Twig Budding and Bark Budding. The first two are sometimes listed as "Shield Budding" and are used almost entirely on the common deciduous fruits. Twig Budding is used on the evergreen fruit trees such as the olive, loquat, avocadro and sometimes on the citrus fruits. Bark Budding is adaptable to those fruit trees which have an unusually thick bark, such as the walnuts, pecans, figs, etc. This process varies considerably in detail and is sometimes known as "Flute," "Ring," "Chip," or "Bark" budding. The last named seems to fit all the conditions and is therefore selected as the best name.

June Budding and Dormant Budding. These do not differ in so far as the inserting of the bud is concerned, but the time of insertion and the subsequent handling differ considerably. The June bud, as the name implies, is put in early in the season and an attempt is made to force it into growth the same year; while with the dormant bud, the insertion is made later in the season, and the efforts are directed toward keeping it dormant until the following spring. In the June bud, an attempt is made to produce a nursery tree from seed in one year, while with the Dormant bud two or more years are required. The former can only be accomplished in the more temperate climates where the trees have a long growing season and where the young buds can grow late into the fall without frost injury to the tender shoots. Even then, only the rapid growing plants like the peach or the almond can be successfully treated. All through the south and the south-

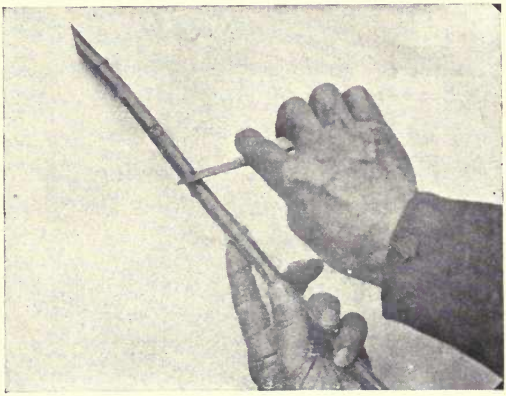


FIG. 27.—Making the " T " Cut for the Bud.

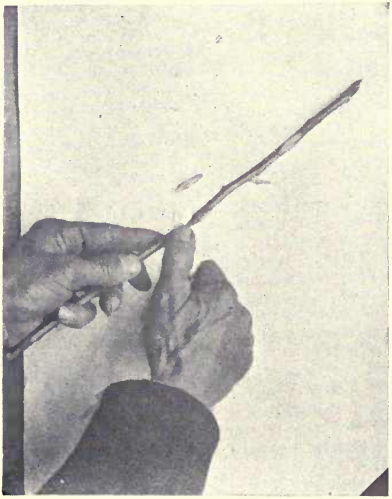


FIG. 28.—Cutting the Buds.

west dormant budding is the prevailing custom, although many nursery companies list June buds as a part of their regular stock.

Inserting the Bud. The process of inserting the bud can best be understood by referring to the accompanying

FIG. 29.—Inserting the Bud.

photographs (Figs. 27, 28 and 29). The budder kneels on the ground, bends the tree over and places it between his left arm and his body, selects a smooth place on the bark, from one to two inches above the ground, and with two strokes of the knife makes a T-shaped cut and slips in the bud. In regular nursery practice the budder does

not do his own tying, but is followed by a boy who snugly wraps the bud with either cord or raffia. This should be done immediately after the bud is inserted and the wraps should be tight enough so the bud will be held firmly in place and cannot dry out. The tie should be so made that the growing point of the bud will not be covered. It is usually best to place all the buds on one side of the plant and away from the sun as much as possible. This will help to prevent a possible injury from sun scald during the winter. In some of the more arid regions of the west, it is necessary to cover the tie with wax as an additional precaution against drying.

After Treatment. If the intention is to produce a June bud, four or five inches are cut off the top of the plant as soon as the bud is in place. If a dormant bud is desired, no pruning will be necessary until the following spring. About ten days or two weeks after the buds have been set, the trees should be gone over and the bands cut to prevent them from drawing into the bark by the growth of the tree. To produce successful June buds the trees have to be gone over three or four times during the season and a portion of the top cut off. This removing of the top forces the bud from below and by the time it reaches one or two inches the entire top can be cut close down to the bud so that the young shoot will take all the sap. If the work has been properly done the young shoots ought to be eighteen inches or two feet by fall.

For Dormant budding the work can be done any time the bark will peel well, from July until late in the fall. It is necessary to go over the trees and loosen the ties, but no

cutting back is done until the following spring. Occasionally, the buds put in early will start the same year but this only happens in the south where the winters are not severe enough to cause much injury. In the spring as soon as growth starts the trees are gone over and cut back to

FIG. 30.—Peach Budded on Almond. One Dormant—One Growing.

just above the bud. As growth starts slowly in the spring, the bud is able to carry all the sap and ought to make a rapid growth throughout the summer, producing a tree from five to seven feet tall in the southern states and from three to five in the northern. The more rapid growing kinds of fruit will make a desirable nursery tree in one

year from bud while the slower growing ones will require two, and in a very few cases, three.

Budding Practice in Large Nurseries. Nursery companies that have to bud a good many thousand trees annually have to work out a very careful system in handling

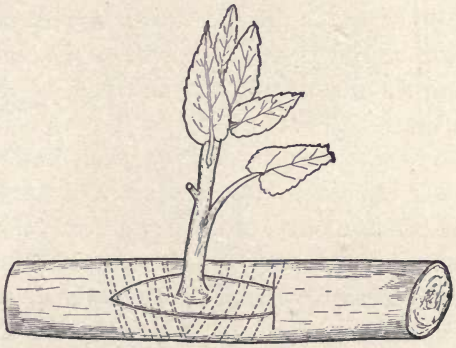
FIG. 31.—Budders and Wrappers in Greenings' Nursery. Munroe, Mich.

the work in order to keep the varieties from getting mixed. The usual method in such cases is to divide the work up into numerous divisions and let one person continue on the same operation throughout the season. The one who cuts buds will do nothing else; the budders do the budding only; the tyers nothing but tying and so on. Only one variety is budded at a time, and before a new one is started

all the left-over buds are disposed of, and the ones budded are located on a permanent map.

Hundreds of men are often employed in a single nursery and it is not strange that mistakes occur. The ability of the management to keep varieties true to name is the greatest factor in the success of the business.

Twig Budding. Many times it is desirable to bud when no dormant buds are available. When growth starts



F.G. 32.—Twig Bud. If Leaf Area is too Large it Should be Cut Back.

in the spring all the winter buds grow out and two to three months must elapse before others form suitable for propagation. During this period twig budding may be done. The process is better adapted to the evergreen fruits, such as the olive and citrus fruits, but may be used as well on the deciduous kinds.

In budding, a growing shoot having but two or three small leaves is selected, cut from the branch the same as the dormant bud and inserted in the same manner. The

cut should be made deep, and a part of the wood on the underside removed so that the bark on the bud will fit close to the wood of the stock and a larger cambium contact made. The fingers should never touch the cambium layers of either stock or bud as the oil from the hands is sure to prevent their growth. The insertion should be made very quickly to prevent wilting of the little leaflets, and then tied in the same manner as for the other buds. If narrow strips of waxed cloth be used in place of raffia, results will be better as there is less danger of drying.

After three or four weeks, or as soon as the bud " takes," the wrapping should be removed and part of the top cut away to increase the flow of sap to the young shoot. If the forcing is too much the bud may be flooded and the work lost. As the season advances more of the top can be removed, a little at a time, until the bud can take all of the sap. The stock is then cut off just above the bud making a close, smooth scar which will soon heal over. This method is too tedious for commercial practice and is best adapted to the working over of young trees or in adding new branches where the shape of the tree is to be corrected.

Bark Budding. This represents a type of propagation that has been in use for a long time but only in recent years has become of general importance. It is best adapted to thick-barked trees such as figs, walnuts, pecans, etc. All of these kinds of fruit trees are much more difficult to bud than the common ones and even under the present best known methods it is difficult to get a high per cent to " take." The bark is too thick for the common budding methods to work successfully, hence bark budding

has recently become the popular method for propagating these kinds of fruit.

The work is performed by removing a piece of bark, about one inch square, from the stock and inserting into the place a patch of equal size. This patch is cut from a twig of the tree of the desired variety and should contain

FIG. 33.—Special Knife for Cutting Bark Buds.

a good dormant bud in the center. The work has to be done carefully and the inserted piece must fit perfectly. The work can best be done in the spring just as the buds are starting to swell, or delayed until fall when good dormant buds can be had. If done in the spring they should be forced into growth the same year, while fall work should remain dormant until the following spring.

Where very much bark budding is done a special knife (Fig. 33) for cutting the exact size of the patch is necessary. This can be made by fastening two thin steel knife blades to a block of wood so that two parallel cuts can be made at one time. Such a tool when drawn horizontally across the bark and then vertically, will cut a square patch the desired

FIG. 34.—Tying up the Bud.

size. If the blades are set about one inch apart, the patch will be one inch square which will be large enough for most work. The same knife can be used in cutting the buds by drawing it around the twig. After the patch containing the bud is removed the sides can be trimmed to secure a perfect fit.

In performing the operation, the patch is first removed from the stock and then the bud cut from the cion. The

two operations should be done as close together as possible. Most of the thick-barked trees contain some organic acid in their bark which will oxidize on exposure to the air. Where too long a time elapses between the cutting

FIG. 35.—A Bud which Has Set and the Tie Removed.

of the patch and the insertion of the bud the exposure to the air tends to inhibit the callusing of the union. It is also important that the fingers should not come in contact with the delicate cambium. A little oil or dirt from the fingers will prevent the buds from setting. At the very best the process is slow and expensive and only very

careful work will result in a high per cent of successful ones.

After Treatment. When the bud is in place it should be tied firmly with raffia or waxed cloth. If raffia is used it should be waxed over to exclude the air and prevent the union from drying out. Many workers prefer the waxed cloth. A strip of cotton cloth is dipped in hot grafting wax and, after drying, is cut into strips about one inch wide. These strips serve the double purpose of holding the bud in position and excluding the air. The point of the bud from which the growth will come should not be covered with the ties although no harm will result from a light coating of wax.

After three to five weeks the patch will have grown fast to the stock, Fig. 35. The subsequent treatment will then depend upon the time the work was done. If budded in the spring part of the top above the bud should be cut back in order to force growth the same year. As the bud develops, more of the top should be cut back until by the time the new growth is five or six inches long all of the tree or branch above the bud can be removed. The first cutting back should not be done until the bud has set. If the work is done in the late summer no cutting back should be done until the next spring when the treatment should be the same as for dormant budding.

Summer Culture of Budded Stock. The cultivation and care of the budded stock does not differ in any essential from that of the seedlings. They should be cultivated regularly and ought to maintain a steady growth throughout the summer. Fertilizers should be used with caution

FIG. 36.—Large Pecan Tree Top Worked by Bark Budding.

as too much nitrogen will force too heavy a growth, and the wood will not mature well in the fall. A succulent over-sized tree is never as good for orchard planting as a stocky medium-sized one.

Sprouting. The heading back of the seedlings to force the bud will also start numerous sprouts on the stock. These are allowed to develop with the bud until mid-summer when the trees are gone over and the sprouts removed. This process calls for considerable experience and the novice is apt to pull off the wrong sprout. In most cases, the differences in the foliage of the good bud and of the sprouts, will be marked enough so that it will be easy to distinguish them. In some cases, where almonds are budded on bitter almond stock or peaches on peach stock, the similarity is so great that the only sure way is to examine the place where the bud was inserted. The sprouter has to crawl along the rows on his hands and knees, separate the undesirable sprouts and strip them off by hand. Sometimes the process has to be repeated, but usually once is enough.

Selecting Buds. Good buds are vital to the success of the nursery. They are not difficult to secure but should be selected with considerable care. The work of collecting buds should be left to one man who is well versed in the knowledge of buds from the various kinds of fruit. He should be able to distinguish a leaf bud from a fruit bud. He ought to know on what wood the fruit or flower buds are born, whether they come singly, in pairs or in threes; whether they developed on the current year's wood or on one or two years' old growth.

The almond, the peach, the apricot and all the rest of

the *Prunus* group, bear their fruit on one-year old wood. Therefore the buds that form the fruit, and the first set of leaves in the spring develop in the fall of the preceding year. The buds that develop into leaves are separate from those that bear the fruit. It is probable, then, in cutting twigs for budding work that many fruit buds will be cut. Of course, the fruit buds are no good for nursery work and in making the selection they should be discarded. It is not always easy to distinguish fruit buds from leaf buds, but with little observation and study, few mistakes need be made. The first buds that appear in the axis of the leaves during the summer's growth are usually leaf buds, but along in July and August fruit buds begin to develop down near the base of the current year's growth and, as the season advances, appear farther and farther out on the terminal branches. They may appear singly, in pairs or in sets of three. Where they appear in pairs or in sets of three one of them is nearly always a fruit bud. In a general way, the fruit buds are a little larger and more plump than the leaf buds, the latter being thin and tapering to a long point.

Bud forms on the apple and pear are quite different from those of the stone fruits. The fruit is always born on two-year old wood hence any bud formed on the current year's growth would necessarily be a leaf bud. This makes the process a fairly simple one with the *Pome* fruits. With the evergreen fruits such as the olive and the citrus fruits, bud formation is quite different. In climates where these fruits can be grown good, dormant buds can be found at nearly all periods of the year. With the various nut

fruits, the buds containing flowers are so characteristic that no one would be likely to make a mistake. The two sexes in the fruit buds are usually separate. The pollen appearing in catkins on the older wood while the pistilate flowers develop on the terminal branches of the current year's growth. These peculiarties of the flowers would make it impossible to secure anything but leaf buds for propagation work.

Collecting Bud Sticks. In selecting buds for nursery work the following points should be carefully kept in mind: First, select only healthy wood from trees that have made a good vigorous growth. Second, twigs from the upper or outer portion of the tree usually have stronger and better developed buds. Third, fruit buds are undesirable and should be avoided.

In collecting bud stick it is customary, where possible, to cut only as fast as needed, because they deteriorate rapidly when exposed. The collector goes to the tree equipped with a wet sack, clips off the twigs with a long-handled pruning shears, immediately cuts the leaves back to within one-half inch of the stem, to prevent evaporation and then rolls them in the wet sack. As soon as enough are cut for the day's work, or as many as are desired, they are tied in a bundle, labeled, rolled up again and taken away for immediate use.

Buds from Bearing Trees. Not all nurserymen select their buds from bearing trees. In fact, very few do this as a regular practice. The custom among the better companies is to use buds from bearing trees every third year, cutting from the previously budded nursery stock the other

two. If buds were selected continuously from bearing trees large orchards would need to be maintained for this purpose, which would add to the expense of the work. Also, the per cent of buds that grow when cut from bearing trees is very much lower than when taken from young trees. One company which buds an average of one million trees a year, estimates that not over forty per cent of the buds taken from bearing trees can be expected to grow, while often ninety-five per cent of those taken from other nursery trees will live and make good trees.

The only argument in favor of using buds from bearing trees is to avoid the possible mixing of varieties. If one or two bad buds should get into the nursery and these be again selected the next year, the error multiplies in a geometrical ratio and in a very few seasons the stock would be in a badly mixed condition. So the practice of returning to the original stock once in three years is a very necessary one.

Shipping Bud Sticks. Sometimes it may become necessary to send buds for some distance by mail or express. This can readily be done if care is taken in preparing them. They should be cut as described above, but instead of wrapping in wet cloth, they should be packed in moss and then wrapped in oiled paper. The moss is kept wet and the oiled paper prevents them from drying out. In this way they can be shipped for two or three days' journey without harm. If a longer journey is necessary, it is best to slip the package, moss, paper and all, into a tin tube that can be sealed up. If this precaution is taken they can be carried a week or even longer without spoiling.

REVIEW QUESTIONS

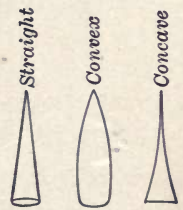
1. What are the general differences between budding and grafting?
2. Under what conditions are each best adapted?
3. Which fruits are generally budded and which grafted?
4. What are the different operations necessary in budding?
5. Discuss the tools required.
6. What is the stripping process, how done and why necessary?
7. Name the different kinds of budding.
8. Define June Budding and Dormant Budding.
9. Explain how to cut and insert the bud.
10. What is the after treatment for the buds that " take "?
11. How does the treatment differ for June budding and Dormant budding ?
12. How do large companies handle the details of budding?
13. Discuss twig budding, where used, adaptability, etc.
14. Define Bark Budding and explain its use.
15. How is the work done?
16. Give the after treatment.
17. Discuss the summer culture of budded stock.
18. What is sprouting and why necessary?
19. Discuss the selecting of bud sticks.
20. Give the method of collecting bud sticks and their after treatment.
21. What is the practice in collecting buds by nurserymen?
22. How are buds handled for shipment?

CHAPTER V

GRAFTING OPERATIONS

THE work of grafting is normally divided into two parts. Those grafts which are used by nurserymen in their regular work of propagation and those used mostly by orchardmen in connection with their practices of production. Of the many types of grafts in common practice the larger number are adapted to the use of the orchardist rather than to the nurseryman. As a matter of fact most nurserymen prefer to bud wherever possible as the cost is considerably less.

Grafting Tools. For the various operations of grafting the tools necessary are a good strong knife, a hand-pruning shears, a saw, a waxing pot and brush and some material for tying up the union. In working over large trees a chisel, a mallet and a two-handled pruning shears should be added to the list. The best knife for the work would be one with a thin blade, made of good steel with the sides of the blade straight as it is impossible to make a straight cut with a blade having either concave or convex sides. This fact can be better illustrated from the following diagrams:



Saws. It is always best to have sharp tools with which to remove the branches that are too large to be cut

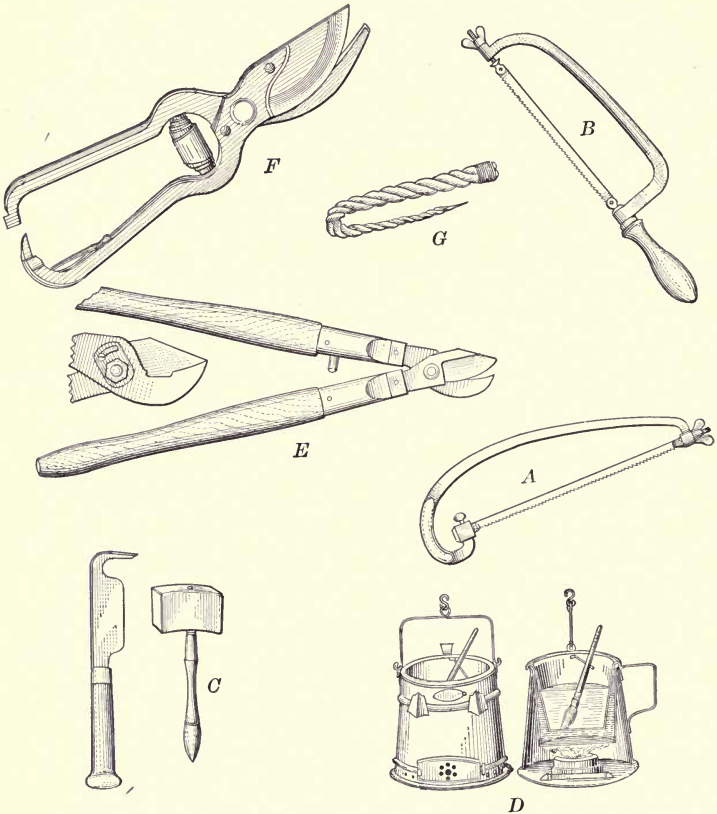


FIG. 37.—Grafting Tools. *a* and *b*, saws; *c*, chisel and mallet; *d*, waxing pot; *e*, two handled shears; *f*, hand shears; *g*, raffia.

off with a knife. The use of shears should be avoided; instead, cut off with a fine-toothed saw. This is espe-

cially necessary on stocks too large to be whip-grafted. The bow-saw, *A*, Fig. 37, is in common use in the western states. In this type of saw the handle fits close in the hand and can be adjusted to a variety of conditions. Both ends of the blade are fastened by means of a swivel bolt which can be adjusted to any angle. One end is fastened with a thumb-screw nut which makes it easy to tighten or replace when broken. A number of saws of this type are now being manufactured and can be purchased at almost any nursery supply house.

Such saws have a thin blade, make a very fine cut and the teeth being set wide will cut through a limb with surprising ease. They can be used with success on branches up to three or four inches in diameter. The blade is made reversible so that the cut can be made by drawing the saw instead of shoving; in this way it is not so easily broken. For cutting large branches a good stiff-bladed pruning saw is desirable.

Chisel and Mallet. For grafting large stock some kind of a splitter is required. Such a tool can be made by a blacksmith from an old file. The blade should be about six inches long and very thin to prevent splitting the stock too far. On the end of the blade is a small wedge, which is used in holding the cleft open while the cion is being set in place. These wedges should be about one-half inch wide, three-quarters of an inch long and thin at the heel in order to work satisfactorily. The mallet can be made from a hard piece of wood, or an ordinary carpenter's mallet may be used. These ought not to weigh over one pound.

Pruning Shears. These do not differ in any way from those used in pruning work. If the shears have good steel and thin blades tapering to a sharp point better results can be had. The shears are not recommended for making cuts that a saw can be used for, but often grafts are made where they can be used to a better advantage. The objection to shears is, that they crush the bark on one side of the stock while the cut is being made.

Grafting Wax. On all grafts that are exposed to the air some covering is necessary to seal up the union and prevent evaporation of moisture. For this purpose a special grafting wax is used. This is made in three different types, known as "hard wax," "soft wax" and "liquid wax." The usual ingredients in all of these are beeswax, resin and tallow. Various other substances are occasionally used, such as oil, turpentine and alcohol. The hard wax is made by melting together the three ingredients, resin, beeswax and tallow and then cooling in a mold. The important thing to remember is the quantity of resin to use. If there is too much, the wax will be too hard and crack in cool weather, allowing the air to enter. If too little is used, the wax will melt and run during the heat of the day. It is easy, therefore, to see that each section of the country may require a slightly different formula.

The soft wax is made in the same way, except it is cooled in cold water and pulled to soften it and make it easy to apply. This wax is used cold and applied to the graft with the fingers. Oil is used on the hands to prevent the wax from sticking. The liquid wax is a combination of the above with the addition of some volatile liquid, usually alcohol.

In this case the wax must be kept sealed to prevent evaporation. When applied to the graft the alcohol evaporates and the wax hardens.

Use of Oil in Wax. All grafting waxes should be made with as little oil as possible. All light oils are very penetrating, and when used in waxes are liable to work through the bark and injure the cambium layer. There is some objection to using oil on the hands when applying the soft wax, as in handling the cions some of the oil may be left on the tender bark. In such cases it is well to handle the wax with gloves, using the bare hands for setting the cions.

Waxing Pot. Where the hard wax is used some provision must be made to keep it warm while being applied. A special waxing pot as shown in *D*, Fig. 37, is used successfully in many places. An old coffee pot with a hole cut in the side for a lamp, and a double boiler in the top works admirably. An alcohol or kerosene burner keeps the water hot, which in turn keeps the wax just soft enough to use and not hot enough to injure the bark of the stock or cion. For applying the wax a brush may be made from a piece of branch and a few fibers cut from a manila rope. This brush can be renewed every few hours and works even better than a hair brush.

Wax Formulæ. There are various formulæ used in making hard wax, but the following works satisfactorily:

Resin	2 pounds
Beeswax	1 "
Tallow (mutton or beef)	½ "
Turpentine	2 ounces

Melt the resin and tallow over a gentle fire, then add the beeswax and when well dissolved remove from the fire and add the turpentine; keep stirring until the turpentine is well incorporated, then pour into molds and set aside until wanted for use.

For the soft wax the same formula as the above is used except the turpentine is omitted. In making soft wax, melt together as in the hard wax. When thoroughly mixed pour it into a tub of cold water and as soon as it hardens remove and work with the hands until soft. It will be necessary to use oil on the hands to prevent the wax from sticking. If the wax gets too soft in working do not use more oil but plunge the mixture back into the water until it is again of the right texture. Twenty minutes or a half hour of pulling the wax ought to get it into a soft pliable mixture which can be applied to the grafts with the fingers.

For the liquid wax the following formula may be used:

Resin	1 pound
Beeswax	½ "
Tallow (mutton)	¼ "
Alcohol	10 ounces

Melt the resin and beeswax over a gentle fire, stirring in the tallow. Take from the fire and when partially cooled mix in the alcohol. If this cools it too rapidly, it must again be placed over the fire, great care being taken to keep the alcohol from burning. When well incorporated and cool, put into tin cases or glass bottles. It should be kept well covered or corked to prevent drying out. In using,

apply with a stiff bristle brush. On exposure to the air the alcohol evaporates and the wax hardens.

Theory of Grafting. The fundamental principle on which the practice of grafting is based is purely a question of plant physiology. Plants have a more or less definitely organized circulatory system. The food is taken in through the roots and passes upward through the outer or sap wood. It is then carried into the leaves where it is converted into the more highly organized compounds and made available for plant growth. Part of this material passes down the trunk of the tree on the line between the bark and the wood. This constitutes the return flow of sap and is known as the cambium layer. This layer forms the wood cells on the inside, and the bark cells on the outside, and the point from which a union must be made when a cion is inserted.

When a union is made between two different varieties of fruit this does not change the function of the cells of either stock or cion. Each cell performs its usual duties up to the point where the sap is passed on to the other wood. The work is then completed by the cells of the cion. If the cells of the stock are not able to supply the sap as fast as the cion can use it, the resulting tree will be dwarfed. This fact is made use of in nursery practice by grafting pear on quince stock to reduce the stature of the tree. If the cells of the cion are radically different from those of the stock, they will not be able to utilize the sap and no union will result. The limits of grafting then, depend more upon the closeness of the relationship of the stock and cion than upon any other one thing.

Any one who is doing grafting work will have several

points to keep in mind. First, the relationship between the stock and cion must be one that will permit of a union from a physiological standpoint. Second, the cambium layer of the stock must coincide with the cambium layer of the cion in order that the sap may be passed from one to the other. Third, every precaution must be taken to seal up the union to prevent the loss of moisture and the consequent drying out. If, in addition to the above, the mechanical part of the operation be executed with care and cleanliness, good results may always be looked for.

Kinds of Grafts. The names applied to the various kinds of grafts are usually associated with some phase of the mechanics of the operation. They differ mainly in the details of the operation and have been the outgrowth of efforts to adapt the work to special situations or conditions. Often several different kinds may be used successfully for the same work. Those most used in the United States may be enumerated as follows:

1. Whip grafts.
2. Side-whip grafts.
3. Cleft grafts.
4. Bark grafts.
5. Veneer grafts.
6. Side grafts.
7. Bridge grafts.
8. Inarching.

Whip Grafting. This is the graft most used by nurserymen in their propagational work. It is used largely on apples and pears though it may be used on other fruits as well. The apple seedlings previously referred to are grown primarily for this kind of work. It is one of the most simple of the many diverse kinds of grafts and may be worked either in the field or indoors. In the latter

case it is usually spoken of as "Bench Working," from the fact that the operation is performed on a bench. This method works best on small stock ranging from three-sixteenths inch to five-sixteenths inch in diameter. Seedlings

FIG. 38.—Bench Working and Whip Grafting.

older than one or two years are best grafted by other methods.

For bench working, the seedlings are dug up in the fall, separated into grades and stored for the winter. Enough for only one day's work is removed at a time. These are taken indoors, washed free from all dirt and they are then ready for grafting. The operation can best be understood by referring to Fig. 39. A smooth place is selected on the root just at the ground line. The seedling is held in the

left hand with the thumb extending toward the top. The knife is then drawn upward making a smooth, even, sloping cut *d*. This should be perfectly straight with the cut

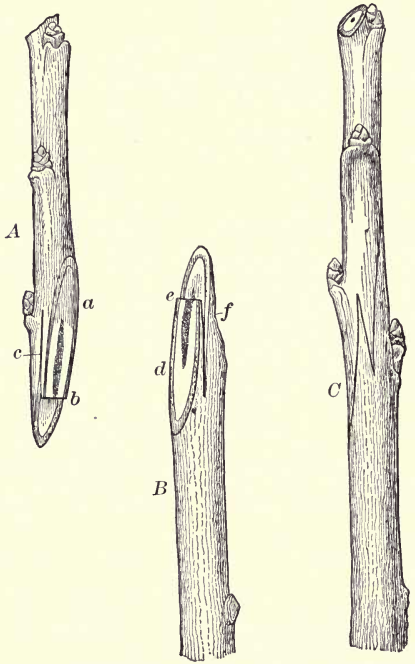


FIG. 39.—Whip Graft. *A*, Cion; *B*, Stock; *C*, Union.

surface about one inch and a quarter long. Then reversing the knife, about one quarter of an inch above the center of this cut, a slit or tongue *e* is made downward. This tongue should not be made straight with the grain but cut slightly across, partially parallel with the face *d*. The

cion is then prepared in the same manner as the stock. This may be from four to six inches long and should contain at least two good buds. The cion is cut off about one-quarter inch above the last bud and should slope slightly away from it.

The two are then joined together, care being taken that the bark of the cion and that of the stock be placed in close contact on one side. It will seldom be possible to unite the cambium layers on both sides because of the variation in the diameters of the two pieces. If one side fits perfectly the resulting union will be just as satisfactory. If the sloping cuts are not perfectly straight or if the tongue is not started above the center of the cut, a close, tight fit can not be had. The grafts are then wrapped with a soft cotton string which has been dipped in melted grafting wax. The wrapping should hold the union snugly in place but should not cover all the surface. One-eighth of an inch should be left between each wrap so the callus will have a better chance to form. Raffia should not be used on whip grafts as it does not decay readily and may cut into the tree by the expanding growth. Where many seedlings are grafted a machine for doing the wrapping can be had. Figs. 40 and 41.

Callusing. As fast as the grafts are completed, they are tied in bundles of fifty or one hundred each, properly labelled and stored away in the callusing bed where they remain until planting time in the spring. The labels must be of some material that water or soil will not affect, as much mixing of varieties in the nursery is due to carelessness in labelling. The callusing bed should be placed where the

FIG. 40.—Machine for Wrapping Whip Grafts.

moisture can be controlled and the temperature will not fluctuate too much. The floor of a cellar or storage house would answer.

For a small quantity, a box of suitable size would answer. The bottom is covered with a layer of sand three or four inches thick on which is placed a layer of grafts. These

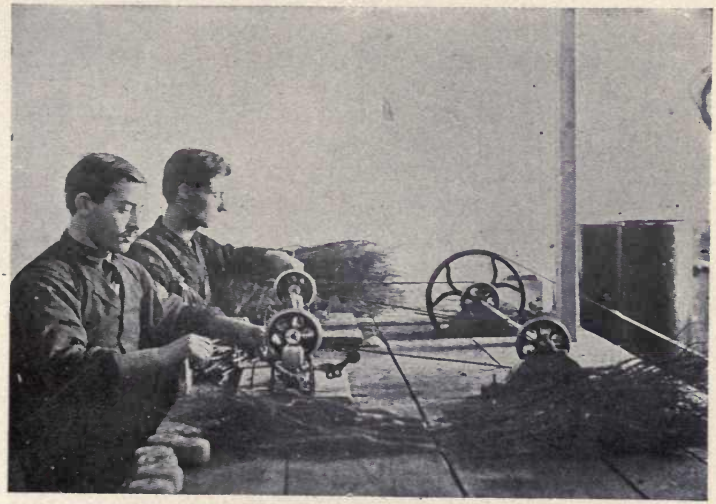


FIG. 41.—Machine in Operation.

are covered with a layer of sand, then another layer of grafts and so on. The bundles of grafts may be stood on end if desired, although the entire bundle should be covered with sand. These must be examined from time to time during the winter to see that they are kept moist and that the temperature remains uniform. If the temperature runs too high the buds will start and no callus form; if too low

the cambium will remain inactive until spring. Between 40 and 50 degrees Fahrenheit will give the best results, but no great harm will result by a drop to 32 degrees. In the spring as the temperature rises the grafts must be watched and as soon as the buds begin to grow they are transferred to the nursery. During the winter small white calluses will form along the line of the union. Where these are not found or where the union has turned black, the cion will not grow and these should be rejected when moved to the nursery. The rejected ones may be planted by themselves. After growing for another year they may again be grafted in the same way.

Piece Root or Whole Root Grafts. Much discussion, in recent years, has taken place as to whether, in making whip grafts, the entire root of the seedling should be used or if a piece of the root would answer. Most nursery companies offer both, with a higher average price for the whole root grafts. The use of whole roots makes it necessary to use one or two-year old seedlings while the piece roots may be cut from older trees. The latter are much cheaper and are often the only ones available. Their desirability for nursery work depends, not on the place where the root was cut, but on the amount of root growth on the mature nursery tree. The consensus of opinion among investigators is that root development is somewhat slower on the older piece roots, but where the roots are healthy and vigorous the resulting tree will be just as good as when the whole root is used.

Some nursery companies, make and offer for sale callused whip grafts. This offers an opportunity for or-

chardists to buy their stock already grafted and only requires two years in the developing of nursery trees ready for the orchard. For this work the whole root grafts are made in two grades, depending on whether the No. 1 or No. 2 seedlings are used. In both of these the root would

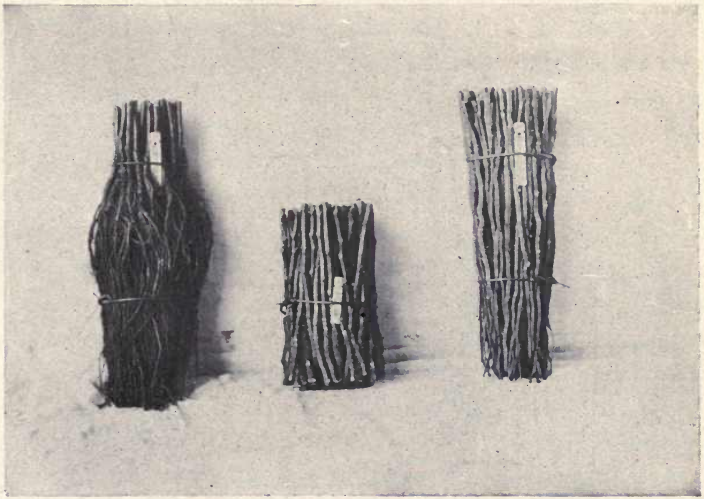


FIG. 42.—Whip Root Grafts. 1. Whole Root Branched. 2. Piece Root. 3. Whole Root Straight.

be cut back to eight inches and the cion to five, making a thirteen-inch graft. For piece root grafts, it is customary to use a four-inch root with a six-inch cion which has been found to give the best results. Prices for whip grafts range from $3.50 a thousand for the piece root to $6.00 for whole root work.

Side Whip Grafting. This is the only other graft of

importance used in regular nursery practice and is a modification of the whip graft. Its chief value over the other one is, that it is adapted to a larger stock, may be used to better advantage out of doors, and accommodates a larger

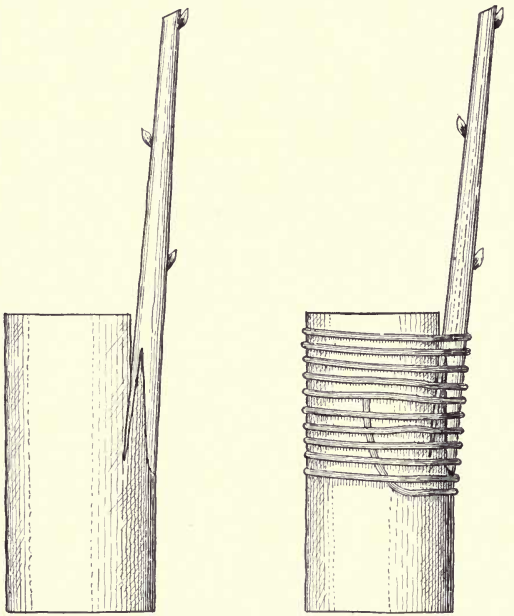


Fig. 43.—Side Whip Graft.

and more brittle cion. For these reasons it is used mostly in the south and the west for the thick-barked fruits, like the walnut or pecan, although it may be used successfully on any fruit tree.

In most cases the union is made close to the ground.

The soil is scraped away from the base of the seedling and the top is removed with a two-handled pruning shears. This cut may be square across or on a slight slant; the latter is usually preferred. The operator kneels on the ground and with his knife makes a cut on the side of the stock as illustrated in Fig. 43. This cut should be about one and one-half inches long, rounding in sharply at the bottom and coming out nearly straight with the grain at the top. The cion is cut in the same way as for the whip graft and inserted in the same manner. The tongue on the stock should start somewhat below the top and run down straight with the grain of the wood. The bottom of the cion should come down as far as the cut on the stock, and make a close, smooth connection. The union is than tied up with raffia or waxed cloth and this is covered with wax. The soil is then pulled back around the base of the tree so as to cover the union leaving only the top of the cion exposed. The process is the same when used on the branches above ground but more attention should be given to the waxing.

Top Working Old Trees. Many trees for one reason or another bear undesirable fruit and are worked over to other varieties. It may be a seedling which has never been grafted or some standard variety unsuited to a particular market or locality. The trees may be only a few years old or of many decades, but so long as they are healthy they may be grafted. There are other reasons for top-working trees, such as vigor, resistance to cold or insect troubles, adaptability to soils, length of life, etc., all of which will be discussed later. An up-to-date orchardist will not have any drones among his trees. They will all be grafted

over to good varieties and made to do their part. Sometimes whole orchards are grafted over to other varieties. (Fig. 44.)

Cleft Grafting. In top-working trees the oldest and probably most used graft is the cleft. This works successfully on branches from one-half inch in diameter up to two or three inches and may be used on those as large as six inches.

Fig. 44.—Working over an Almond Orchard to Prunes in California.

Cions may be placed down close to the ground or up in the tops of old trees. The work should be done in the spring before growth normally starts and while both stock and cion are still dormant. Summer grafting may be done, but the practice is not general.

In performing the operation, the stock is cut squarely across with a fine saw and a cleft made down about one and one-half inches. The cion should contain at least

two good buds and be three or four inches long. The lower end is cut to a wedge shape, making the slope the same length as the depth of the cleft in the stock. The cleft

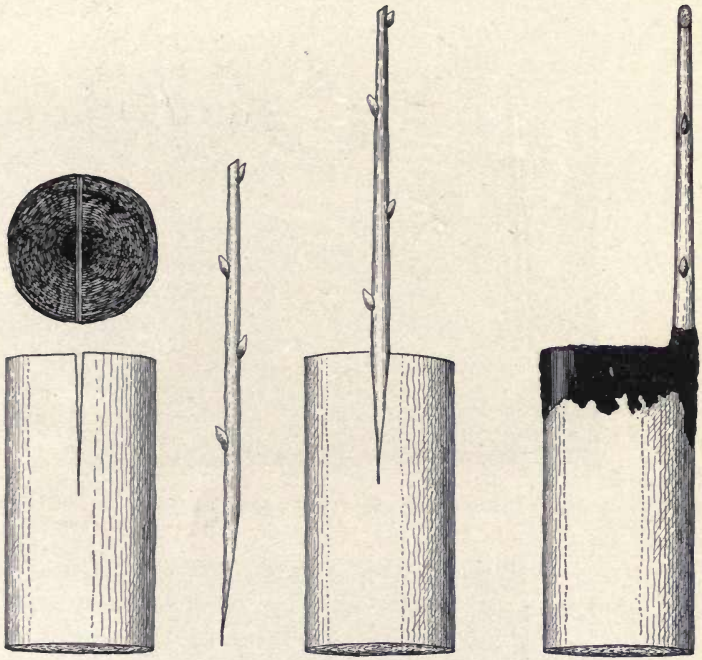


FIG. 45.—Cleft Grafting.

is then pried open with the splitter, previously mentioned, and the cion inserted, being careful to have the cambium layers of the two pieces closely united. If the inner edge of the cion is made slightly thinner than the outer the

FIG. 46.—Young Tree Cleft Grafted.

FIG. 47.—Same Tree as Fig. 46 after Two Years' Growth.

union will fit better. If the stock is one inch or more in diameter two cions are inserted. If both grow, one can be removed at the close of the first year. It will also be necessary to guard against the crushing of the tender cion from the spring of the wood in making the cleft. To avoid this, two methods are available. One is to put a small wedge in the center of the cleft to ease the pressure off the cion. The other is to make the cleft across the edge of the stock rather than through the center. The latter method is preferable as it is easier to make and permits of healing somewhat quicker than where split through the center. Besides, the position of the cleft can always be regulated so as to get just enough pressure to hold the cion in position and make tying unnecessary.

After the cion is in position the union should be waxed over. If the stock is a very small one it will be necessary to tie the graft, but on the larger limbs the natural spring of the wood will hold the cion as tight as necessary. The wax should be applied to all the exposed places, covering the entire end of the stock and down the side as far as the cleft goes. Sometimes a drop of wax is placed on the end of the cion. If the waxing is done some time before growth starts in the spring, it may be necessary to go over the grafts a second time to be sure that all of the unions are properly sealed up. Not all the cions will grow and many that do grow will not start until some time after the normal growth.

The grafts will have to be watched through the summer and as the growth develops some pruning will be necessary. Sprouts will often develop around the graft and these will

have to be kept off so they will not interfere with the cion. If it is a case of top-working an old tree, some of the other branches may grow in the way and prevent proper branching of the cion. All these should be watched and everything cut away that would interfere with the correct development of a new top. An old tree may be top-worked completely in one year or two or more seasons may be used.

FIG. 48.—A Top-worked Tree Leaving "Nurse" Branches.

It is not necessary to leave a few branches as "nurse" branches for one year while the rest are being worked over. This practice is common in some sections of the country and as far as is known gives good results.

Veneer Grafting. This is variously known as "V" grafting or notch grafting. Its use is chiefly as a substitute for cleft grafting as it is not necessary to split the stock. A V-shaped cut is made in the side of the stock where the

cleft would ordinarily be made. This is cut through the bark and into the wood, its size and depth being regulated by the size of the cion to be used. The cion is cut in the same way as for the cleft, only the lower end is cut

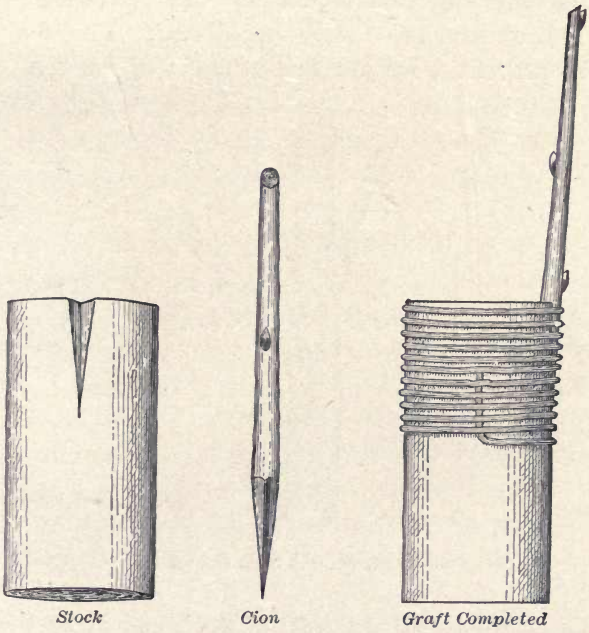


FIG. 49.—Veneer or V Grafting.

V-shaped instead of a wedge. In large stocks, the cut may be made with a saw and the edges trimmed out to the V shape with a knife.

The V cut of the cion fits into the notch of the stock and the cambium layers are joined as in the cleft. (Fig.

49.) It is then tied up with raffia and all the exposed area waxed over. This method works well on hard wood and where the cions are large and inclined to be brittle. It is also better adapted to larger branches than the cleft is. Its only objection is that the cions sometimes blow out before they get firmly established. This, however, can be prevented by judicious pruning of the cion or by

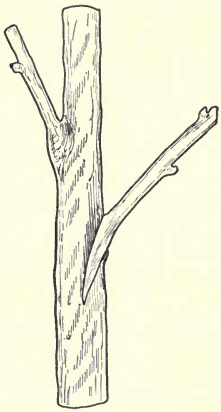


Fig. 50.—A Side Graft.

nailing a lath to the side of the stock and tying the cion to this as the growth develops. It is used largely on the Pacific Coast where it is looked on with favor as a good substitute for the cleft graft.

Side Grafting. This method is used to a limited extent to place an extra branch on a young tree or fill in where one may be missing. It may be used on shrubs as well as fruit trees. It works best on stock from one-half up

to two inches in size. The top of the branch is not cut off, but is bent over and a downward sloping cut made into the side where the new limb is to be placed. The cion is then cut with a long sloping face as shown in Fig. 50. This is fitted into the stock by bending it over, care being taken to get the cambium layers to fit closely along one side. The union is then tied up and carefully waxed over. It is also possible to renew the top of a tree by this method. The graft is placed on the smaller branches and as soon as growth starts the part above is cut off close to the union.

Bark Grafting. This is a method of top-working trees which may be used after growth has started in the spring. All the other grafting operations should be done while the trees are still dormant. If this is impossible the method of bark grafting may be used. In this process the important thing is to keep the cions from starting. They may be collected in the usual way and placed in cold storage, or if this is not available, bury them in the sawdust on top of the ice in an icehouse. By these methods the cions may be kept dormant from four to six weeks beyond the normal growing season.

To bark graft, the stock is cut in the same manner as for cleft work. The bark is then cut down for an inch and a half and the corners carefully loosened from the wood. The cion is cut with a long slope on one side only (see Fig. 51). This is then inserted in the stock between the loosened bark and the wood, placing the cut surface of the cion next to the wood. It is tied up with raffia and waxed over as for the other grafts. The two unite quickly

and growth is apparently as strong and as good as any of the other methods.

Inarching. *Grafting by Approach.* A method adaptable to many ornamental plants but may also be used in orchard work. Two plants or two parts of the same plant are

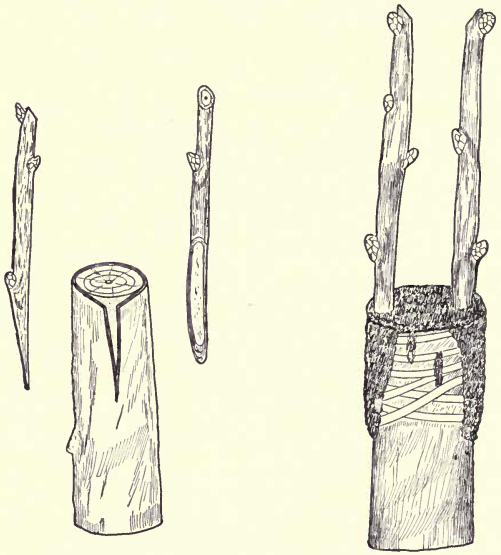


FIG. 51.—Bark Graft.

brought together and a union made by cutting through the bark at the desired point of contact. Various fancy forms such as cordons, arches, trees for growing against walls, etc., are formed by this method. Natural braces for fruit trees may also be made. (See Fig. 52.) Two small twigs extending from different branches are brought together

and the ends untied. These enlarge as they grow, getting strong enough in time to support the limbs and do away with props.

FIG. 52.—Inarching.

Bridge Grafting. Often trees may be injured by accidents, such as fire, carelessness in cultivating or plowing, or by mice and rabbits during the winter. Such injuries weaken the tree by cutting off part of the food supply

and if they extend all around the trunk, the tree is completely girdled and will die. If such injuries are discovered before growth starts in the spring, the tree can usually be saved by bridge grafting. In case the trouble is the result of summer injury the remedy is not so easy but may be used successfully. Where the bark has been off for two or three years but resulting in comparatively small wounds the same remedy may be used. If decay has started in the wood, this may be checked, but new wood cannot be grown.

If the injury results in a complete girdle, the first thing to do is to trim off the edges of the old bark down to fresh cambium, both above and below the wound. The cions may be cut from the same or similar trees and should be of the current year's growth. The distance is carefully measured across the injury and the cions cut a sufficient length to reach across and extend one and one-quarter inches under the fresh bark both above and below the wound. Both ends of the cions are cut to a face similar to the one used in the bark graft. These are then inserted under the bark at both sides of the injury placing the cut face next to the wood of the tree. If a cion can be placed every inch around the girdle results will be much more satisfactory. They are then tied up and waxed over, being sure to cover all exposed areas.

If the injury occurs close to the ground the soil may be pulled up around the cions after they have been set and waxed. Old wounds running only part way around the trunk may be healed in the same manner. If the injury is small, the bark of the stock is cut so as to let the

cion lay as flat as possible, but in the case of a large injury a T cut may be made as in budding and the cion put in place by bending. (See Fig. 53.) If the injury is narrow and long the cions may be placed diagonally across the opening rather than vertically as in the others. The cions enlarge as growth develops until after two or three years

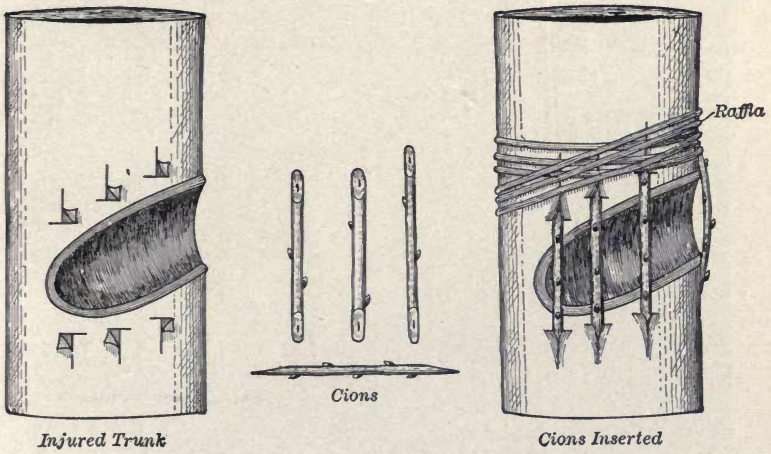


FIG. 53.—Healing Over an Injury by Bridge Grafting.

they will come together and the injury will be entirely healed. Bridge grafting is applicable to the common deciduous, forest or ornamental trees as well as to fruit trees.

Collecting Cions. Good cions are essential to good trees and should therefore be collected with considerable care. It is first of all, important to know the trees from which the cions are taken. A strong vigorous tree bear-

ing regular crops can be expected to reproduce this character from its vegetative parts. Every part of a tree is not necessarily of equal vigor. The lower branches receiving less sunlight are not as vigorous as the ones higher up. Trees growing on good soil will produce better cions than trees from poorer soil. As in the case of bud sticks

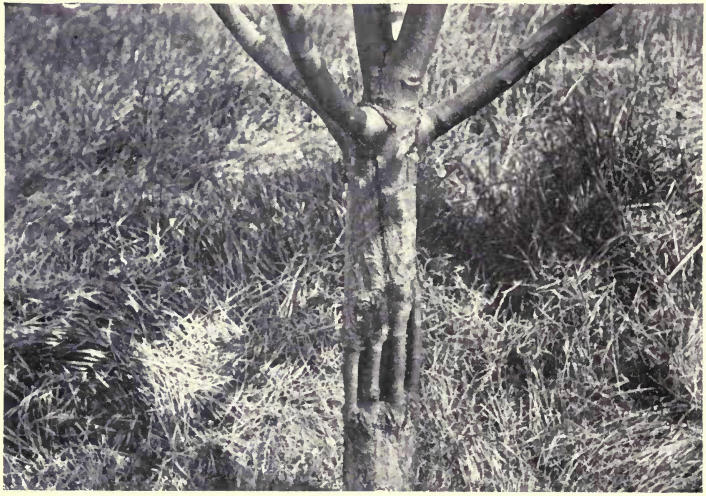


FIG. 54.—Bridge Graft after Two Years' Growth.

select cions from those trees which have good bearing records and from the most vigorous parts of those trees.

The best cions are obtained from one year old wood of an average growth of from eighteen to twenty-four inches. The longer the growing season of any locality the larger the cions that can be had. Where only a few are needed they may be cut as fast as used. In top-working trees

it is preferable to use the cions as soon as possible after cutting. Where winter conditions are severe enough to cause injury cions should be collected in the fall, sometime preceding the expected heavy freezes. In other localities any time through the dormant season will answer.

The cions are clipped from the trees, tied up in bundles, properly labelled and carried away to some convenient storage place. They may be placed in a box, and covered with sand, and set away in some cool moist place until needed. They should be examined from time to time to see that the sand does not become dry. The temperature ought not to get above forty-five degrees as there will be danger of the buds starting. If proper attention be given to moisture and temperature cions may be kept all through the dormant season without any appreciable loss of vitality.

REVIEW QUESTIONS

1. Contrast grafting with budding as to their importance in nursery work.
2. Describe the tools necessary for grafting work.
3. Describe the different grafting waxes and explain how they are made.
4. Why is an oil objectionable in any grafting wax?
5. How are waxing pots made?
6. Give the theory of grafting.
7. List the various grafts and explain where used.
8. Discuss the whip graft—how made and after treatment.
9. What is a callusing bed, how made and purpose?
10. Give the relative importance of piece root and whole root grafts.

11. Explain the use and how to make the side-whip graft.
12. What is " Top Working," the importance and objects of it?
13. Explain Cleft grafting, how done and where desirable.
14. Explain Veneer grafting, how done and where desirable.
15. Explain Side grafting, how done and where desirable.
16. Explain Bark grafting, how done and where desirable.
17. Explain Inarching, how done and where desirable.
18. Explain Bridge grafting, how done and where desirable.
19. Give the essential points in collecting and handling cions.

CHAPTER VI

PROPAGATION BY CUTTINGS

Cuttings. A cutting is a portion of the vegetative part of a plant which may be treated in such a way as to form a new individual. The resulting tree will be in every respect the exact duplicate of the parent from which the cutting was taken, and will need no further treatment in the way of budding or grafting in order to reproduce the same kind of fruit or flower. Plants propagated vegetatively are just as stable, just as hardy, and in every way equally as suitable for the production of fruit as those grown by the usual methods of budding or grafting.

Every kind of fruit, so far as is known, can be reproduced from cuttings. The method is practical, however, for only a few kinds, as other ways are easier and less expensive. The various fruits are in no way uniform with respect to the ease with which they may be propagated from cuttings. Some grow readily from any portion of the plant, others only certain parts can be used. A number, including most of the nuts and stone fruits can only be grown with great difficulty. It is fortunate for the nurseryman and the orchardist that those fruits which are the most difficult to grow from seed, reproduce with ease from the vegetative parts.

Fruits Grown from Cuttings. The various fruits that are usually grown from cuttings may be classified under the following heads:

THE USUAL METHOD

Bananas	Gooseberries
Currants	Grapes
Dates	Mulberries
Doucine	Olives
Figs	Pineapples
Filberts	Pomegranates

Quinces

OCCASIONALLY USED

Apples	Mangos
Citrus fruits	Persimmons
Guavas	Pears
Loquats	Plums

Parts Used. In nearly every case where fruits are propagated from cuttings some part of the trunk or branch is used. Occasionally roots are taken, but in no case can leaves be used successfully. With the pineapple and the date the cuttings are generally called "Suckers" and are off-shoots that appear in the axils of the leaves. These sometimes take root while still attached to the parent plant, but are usually removed in the early stages of growth and rooted in the ground.

Classification of Cuttings. Stem cuttings may be classified according to the degree of maturity of the wood from which they are made. Dormant or Hardwood cuttings are where the plant has partially or wholly com-

pleted the year's growth and passed into a quiescent stage. If the plant is in active growth the cuttings would be semi-dormant. Cuttings taken from the young shoots of the current year's growth or from the sub-tropical fruits, which never pass into a complete dormant stage, belong to this class. Then there is a third type of cutting made from plants which have only soft or succulent growths. Such plants as geraniums, cacti and many other flowering kinds belong to this type. Vegetative propagation from such plants would be called Softwood Cuttings.

Principles Involved. The different classes of cuttings are widely variable in their physiological and chemical activities and should therefore be treated differently in the processes of propagation. Plant Physiologists tell us that every part of the individual plant has in it, potentially at least, all the essentials necessary for the production of the mature individual. As the cell is the unit of the plant so in that cell is located everything necessary to develop the future buds, roots, leaves and flowers. That some cells possess this quality to a greater degree than others is amply proven by the ease or difficulty with which different cuttings may be used for propagation.

The part of the plant tissue possessing the greater value in propagation is closely associated with the cambium layer. In fact the same tissue which makes possible budding and grafting produces the new buds, roots and leaves where cuttings are used. The cambium layer, then, containing the primary or unorganized tissue is the important part. The stem and root cuttings of the ordinary trees and shrubs have this tissue just beneath

the bark, while most of the leaves and the body tissue of the lower forms have it distributed through the entire plant in more or less definitely organized bundles. Most of the softwood cuttings belong to this class, which makes it necessary to give them a different treatment.

Cuttings made from dormant wood have the cambium layer inactive, and the cells contain abundance of stored food, which under normal conditions would carry the life processes forward, until such time as leaf growth would enable the plant to manufacture more. Under such conditions growth starts slowly. Ample time should be given dormant cuttings that the cambium may throw out a callus to cover over the wound. The temperature should be raised gradually so that the stored food may be able to take on its natural functions without too much haste. In the case of cuttings taken from active growing trees, the cambium is active, little reserve plant food is available, hence a long quiescent period is apt to result in decay. The growing tissue must be provided with food and moisture, and conditions made favorable for a continuation of growth. This is done by leaving on a portion of the leaves to manufacture food, removing only what is necessary to prevent undue evaporation of moisture, by making the lower cut close to a node or bud where the cambium tissue is more abundant and by keeping the atmosphere and soil conditions surrounding the cuttings more humid or moist. These conditions are most favorable to growth for the softwood and the semidormant cuttings, and the details of the work consist in the applying of these principles in the most practical way.

Callusing Bed. Dormant cuttings like the whip graft must be put through a callusing process before planting in the open ground. This may be done in exactly the same way as the whip grafts. The cuttings are made in the fall or early winter, tied up in bundles, properly labelled and placed in the callusing bed. If sand is used it may be placed in a cellar where the temperature will not get above fifty degrees before spring. If possible, the temperature should be held around thirty-two until mid-winter and then raised gradually until planting time in the spring. The cambium runs out at the cut ends of the twigs and forms a white callus which later in the spring throws off roots. The roots do not always come or form from these calluses but may develop around the buds or nodes. In some plants, as the willow, they may develop at any point between the nodes. This latter represents adventitious buds which have formed in the cambium layer and forced their way through the epidermis.

Where dormant cuttings are made on a large scale it is often desirable to have a callusing bed out in the open, particularly is this true in the warmer states. Such a bed may be located in any convenient place where the soil is of a sandy nature and the drainage good. Under such conditions the cuttings should be made early in the fall, it frequently being necessary to strip the leaves from the twigs used. They would then be tied in bundles and buried in the bed with the small ends downward; the upper end being only two or three inches below the surface of the ground. The sun shining on the ground makes the soil near the top a little warmer, which tends to hasten the cal-

lusing without materially disturbing the part that is buried deeper.

After the cuttings have remained in these beds for several weeks they are removed and planted in the nursery row. This is best done late in the fall when no growth can take place until spring. If they are to be left in the beds over the winter the bundles should be dug up and reburied, laying the cuttings flatwise. They should then be covered with sufficient soil or mulch to prevent freezing during the colder months. It should be mentioned in this connection that the roots normally spring from the end of the twig that was closest to the roots before cutting Also that root cuttings will throw out branches from the end that was normally closest to the trunk. This condition is known as *polarity* and is probably the result of the same magnetic effects which causes branches to grow up and roots to grow down. It is not at all impossible to reverse root growth, as may be illustrated in black raspberries which are rooted from the tips of the canes. In this particular case the roots form from the node just below the dormant bud and the latter point downward when growth starts, but soon reverses and grows upward.

Kinds of Cuttings. Numerous names have been applied to the various cuttings depending partially on the wood taken and partially on the after treatment. Those most commonly used in connection with the propagation of tree fruits may be classified as follows:

Single eye cuttings	Mallet cuttings	Tip cuttings
Simple cuttings	Root cuttings	Softwood cuttings
Heel cuttings	Nurse root cuttings	Truncheons

Single Eye Cuttings. Where wood for cuttings is scarce, a single bud or node with a portion of the wood on both sides may be used. This is sometimes done with rare varieties of grapes, roses and many of the ornamental

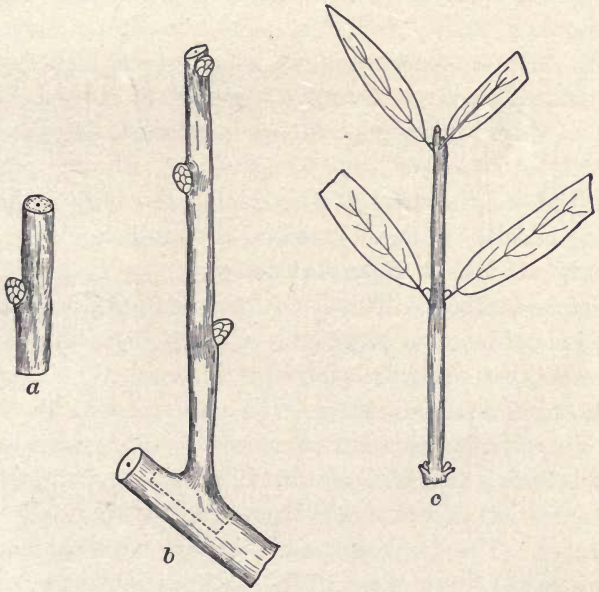


FIG. 55.—Types of Cuttings. (*a*) Simple Cutting. (*b*) Mallet Cutting. (*c*) Tip Cutting.

shrubs. This method works best where bottom heat can be had as in greenhouses or glass propagating houses. It is difficult to use in the open ground unless the variety is one especially easy to grow. (See *a*, Fig. 55.)

Most nursery companies are provided with glass houses, especially arranged for the work of propagation. Benches

or beds are used, which are so arranged that a gentle bottom heat may be applied at any time. Either hot water or steam may be used. The benches are filled with a fine clean sand in which the cuttings are placed. If the single eye cuttings are made of dormant wood they are first callused as described above and then placed in the propagating bench. The temperature is started at about fifty degrees and gradually raised, through a period of several weeks until a normal-growing condition is reached. If the cuttings are softwood or semi-dormant the callusing process is omitted and the cuttings placed immediately in the propagating bench. With this method the sand should be free from organic matter to prevent decay.

Simple Cuttings. This is the common form of cuttings used in outdoor propagation. Grapes, figs, mulberries and sometimes olives are grown by this method. One year old dormant wood is usually taken, although with the olive and citrus fruits the semi-dormant is sometimes used. As each fruit is treated somewhat differently in this method of propagation each one will be considered separately.

Grapes. The simple cutting is the only practical method for propagating the grape. The cuttings are made either in the fall after most of the leaves have dropped, or sometime through the winter in connection with the pruning. They should be made of well-matured wood of one season's growth and should be from sixteen to twenty inches long. The lower end should be cut close to the bud or node and the upper end within a half inch of the node. If cut late in the fall they may be transferred direct to the nursery row. A good deep sandy loam is prepared as for

a seed bed and the cuttings set by means of an iron bar. Holes are punched deep enough to admit the cutting, leaving only the last bud sticking out. These are then made compact in the soil by pushing the bar down a few inches to the side. From fifty to eighty per cent will take root by this method.

Where the cuttings are made through the winter they are taken to the callusing pit where they remain until spring before setting in the nursery row. Where calluses form, the cutting may be expected to grow; if the ends have turned black it should be discarded. Where the European varieties are grown, as on the Pacific Coast for raisins, it often becomes necessary to graft the standard varieties on to stock that is resistant to the grape *phylloxera*. Most of the American species are resistant to this insect hence they may be used for stock for the European varieties. The cuttings are made in the usual way but before rooting they are grafted to the desired variety as illustrated in *b* Fig. 56. The union is very similar to the one used in whip grafting apples, except that the cut is more nearly straight across the stock.

If the work is done carefully no tying or waxing will be necessary. The buds below the graft are cut off so other sprouts than the one desired will not start. One or two buds on the bottom of the stock are left from which roots can develop. After the grafting is done, the cutting, graft and all, is placed in a special callusing bed where the temperature can be controlled. Calluses form on the ends of the cutting and at the union at the same time. These remain in the beds until spring when they are trans-

ferred to the nursery and treated the same as for the ordinary cutting. One season is usually enough to form a

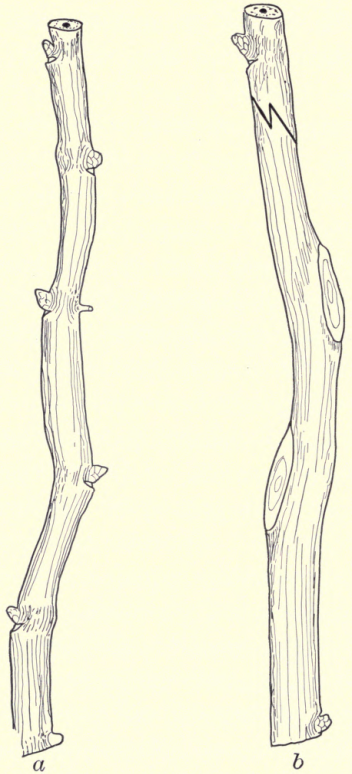


FIG. 56.—(*a*) Simple Grape Cutting. (*b*) Grafted Grape Cutting Showing Method of Dis-budding.

fair root system, though many nurserymen prefer two years before setting in the vineyard.

Figs. Seed from commercial figs can be germinated only with great difficulty even under the best greenhouse conditions. They are, however, easily propagated from cuttings. These are ordinarily made about ten inches in length, using wood that calipers from three-eighths to three-quarters of an inch in diameter. The bottom end is cut close to a bud as in the grape. In fact it should be cut right into the wood partition, so that there is no pith cavity left at the bottom end of the cutting. In the warmer parts of the United States where figs are commonly grown the cuttings can best be made in January or February. They are tied into bundles and placed in the callusing bed bottom end up. The ends soon heal over and by the latter part of March they can be transplanted in the nursery row. Sufficient moisture should be provided that they will not dry out during the summer.

The other fruits that are sometimes propagated by means of the simple cutting are the mulberry, quince, pomegranate, currant, gooseberry and occasionally the apple and some of the citrus fruits. The treatment for all of these is very much the same; the cutting is made when the wood is dormant, or as near as may be, placed in the callusing bed in the fall to heal over and then removed to the nursery row. In the warmer parts of the country where the falls are late and the fruit wood matures early it is best to remove the cuttings from the callusing bed and set in the nursery before very cold weather. In the colder states they are better left in the beds over winter and set in the nursery in the spring.

Heel Cuttings. It sometimes happens that the

simple cuttings will start much more easily if a part of the branch from which it is taken is removed with it. This piece is known as a " heel " from which the cutting takes

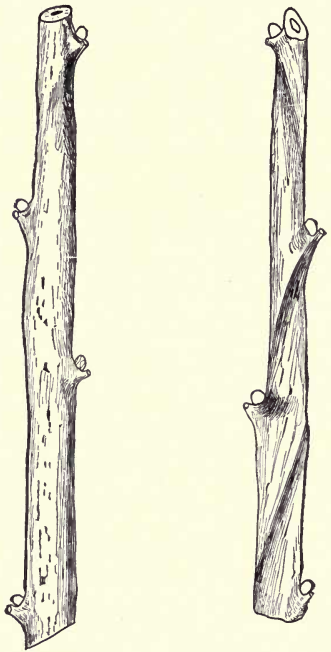


Fig. 57.—Cuttings as Sometimes Used on the Citrus Fruits.

its name. (See *b*, Fig. 55.) The number of cuttings that can be made by this method is much less than the simple way as each branch can produce but one. The grape and the olive are sometimes grown in this way when the other methods fail. The doucine stock which is used for a

partial dwarfing of the apple is propagated in this manner. The top of the main tree is cut off, thus forcing many adventitious buds along the stem and around the base. When these have made one year's growth they are pulled or cut off of the parent plant and treated as a cutting. Roots readily form from the enlarged base.

Mallet Cuttings. This method is very similar to the one just described. Instead of cutting out a piece at the base of the branch, the entire limb is removed and a short portion left with each cutting. It possesses no particular advantage over the heel cutting,—the chief purpose being to aid in the pruning of the tree. Unless the plant is grown for the purpose of producing cuttings only, the removal of the piece for the heel cutting will leave the branch so weak that it would have to be removed. In all such cases it is just as well to cut the branch off first and then make the mallet cutting. The piece which constitutes the mallet should not project more than one inch on each side of the cutting proper. If the cut can be made with a knife instead of a saw the roots will start more easily. Fig. 55 (*b*) represents a mallet cutting, while the dotted line running through the base indicates where the cut should be made to produce a heel cutting.

Root Cuttings. Practically all the tree fruits that will grow readily from cuttings made from the branches may be similarly grown from pieces of the roots. In the case of budded or grafted trees this practice would be of no value, as such root cuttings would only produce stock on which other varieties would have to be worked. Where roots are used for cuttings, branches should be selected

that caliper from one-quarter to one-half inch in diameter. These should be cut from eight to ten inches long and put through the same treatment in the callusing bed as the simple cutting. They may be taken either in the fall or spring and will often work successfully where cut in the summer. After the calluses are formed they are transferred to the nursery row, placing them from six to eight inches apart. Often sprouts may be produced from roots by the simple method of severing the smaller roots from the parent plant without disturbing their feeding tips. Buds will form near the end from which shoots will grow. When these are one year old they are dug up and treated as new plants.

Nurse Root Cuttings. This is a somewhat new departure in tree fruit propagation. It is being worked in a practical way in a number of nurseries and has given highly satisfactory results. The cutting is made very similar to the simple one except that it is not so long, eight to ten inches being sufficient. On the bottom end is placed a small piece of root known as a nurse root. This is grafted on as illustrated in Fig. 58 or a simple whip graft may be used. This root gives the cutting a quicker connection with the soil, then later as growth develops new roots form from the cutting proper, which eventually become the chief support of the tree.

This method was the outgrowth of a series of studies of the influence of stock on the cion. It was found that many desirable varieties of fruit were lacking in vigor due partially to the poor union with the stock and partially to the inherent weakness of the variety itself. Such are

often improved when grown from rooted cuttings. Some varieties of fruit are more resistant to diseases than any root

FIG. 58.—Nurse Root Cutting.

on which they may be worked. This may be illustrated by the resistance of the Northern Spy apple roots to the

woolly aphis. Often varieties of fruit are better adapted to local conditions, such as extremes of humidity, low temperatures of the north or the prairies of the northwest when grown from their own rooted cuttings. In most of these cases, the nurse root is the best method where the varieties do not root readily from their own cuttings.

Tip Cuttings. This is a method where semi-dormant wood is used and is adapted to such fruits as the olive, loquat and ornamentals like the oleander which are evergreen and have a more or less heavy foliage. The olive in particular is propagated in this manner in a number of nurseries in California. Mr. W. T. Kirkman, of Fresno, describes the process as follows: "The cuttings are made about three inches long from the tip wood, or small wood near the tips of the branches. Two leaves are left on each piece near the top of the cutting,—the bottom end is cut close to the bud—in fact, right against the bud. These small cuttings are best made in October and should be immediately placed into a sand bed, where they are rooted. It is usually necessary to supply a medium bottom heat during the winter." These rooted cuttings are placed in the nursery row in the spring where from one to two years is required to produce a nursery tree measuring from three to five feet in height. (See *c*, Fig. 55.)

Truncheons. Some few fruits and a number of kinds of trees may be grown from pieces of wood ranging much larger in size than used in an ordinary cutting. Such pieces used in propagation are known as truncheons. The method is slow and not altogether satisfactory, but nevertheless is used in Europe to some extent in propagating

the olive. The branches from one-half inch to three inches that are cut off in pruning are carefully saved and used for production of new trees. The small pieces are split in half, while the larger ones are quartered. These are then buried in the propagating bed, placing each piece in a horizontal position with the bark uppermost, and from three to four inches below the surface of the ground. This is best done in the early spring, moisture being supplied throughout the summer and clean culture given. The buds at the nodes gradually develop into branches and roots

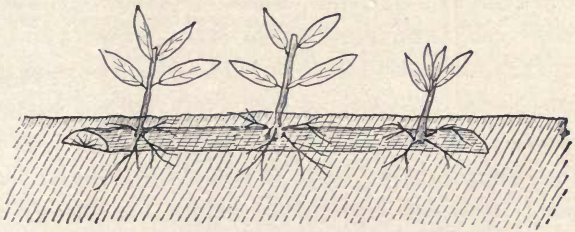


FIG. 59.—Propagating Olives by Use of Truncheons.

form around their base. After two summers' growth the entire truncheon is dug up and the pieces containing the desired sprouts are cut off with a saw and transferred to the permanent grove. Occasionally three years will be necessary to produce a good tree. (Fig. 59.)

Softwood Cuttings. Unless the suckers or offshoots used in propagating bananas and pineapples may be classed as softwood cuttings, this method would have little use among nurserymen. It properly belongs in a discussion of the methods of vegetative propagation used in the great class of soft, succulent perennials so common to the florist.

For all of this class of plants which do not readily reproduce from seed this method is by far the most important.

To get the best results with softwood cuttings, greenhouse conditions are necessary. A good propagating bench, with five or six inches of clean, coarse sand, facilities for providing bottom heat, an even distribution of temperature and a close glass cover for the bed to regulate the humidity, are some of the conditions necessary. For all such cuttings three principles should be kept in mind: First, young wood formed somewhat late in the life of the individual will root the easiest. Second, the cuttings are made while the plants are in active growth and they should, therefore, contain just sufficient leaf surface to keep up the life processes of the plant and not enough to cause undue loss of moisture. Third, in regard to moisture and temperature, keep the cuttings under similar conditions in which the parent made the best growth. Roots will form in a short time, when the cuttings are removed from the propagating bed and treated according to the requirements of each individual.

REVIEW QUESTIONS

1. What is a cutting?
2. What fruits are usually propagated by cuttings?
3. What parts of plants may be used as cuttings, which are the most common?
4. How are cuttings classified?
5. What principles are involved in growing plants from cuttings?
6. Describe the callusing bed and how used.
7. Give the various kinds of cuttings.

8. Explain the use, preparation and treatment of the following kinds of cuttings:
   (*a*) Single Eye Cutting.
   (*b*) Simple Cutting.
   (*c*) Heel Cutting.
   (*d*) Mallet Cutting.
   (*e*) Root Cutting.
   (*f*) Nurse Root Cutting.
   (*g*) Tip Cutting.
   (*h*) Softwood Cutting.
   (*i*) Truncheon.
9. Review the general importance of cuttings in nursery work.
10. Compare cuttings with grafting or budding as to vigor, productiveness, etc.

CHAPTER VII

THE AFTER TREATMENT OF NURSERY STOCK

Whether or not a desirable nursery tree can be produced in one or two years from the bud or graft will depend upon two things: first, the particular kind of fruit and second, upon the length of the growing season. Where the average length of the growing season runs from ninety to one hundred and twenty days, two years will be necessary for most kinds. This would include most of the region of the United States lying north of the cities of New York, Chicago and Denver. South of these cities the season is long enough that all of the more rapid-growing fruits will develop in one year from bud. Even such trees as the Persian Walnut will often grow from six to nine feet in a single year from grafts. This would seem at first thought to give the south a big advantage in the economy with which the work can be done. While this may be true in specific cases, the advantages are more than offset by the greater number of insects and diseases that have to be contended with.

Summer Culture. The culture of nursery trees does not differ in any material way from many of the farm crops. Clean cultivation is necessary. All weeds are kept out and the soil stirred enough to conserve the moisture. The most important part of the work is to make the young trees keep a steady and regular growth through-

out the season. A stunted tree is always undersized, lacking in vigor and more subject to attacks of insects and fungus diseases. In most sections of the United States there is always danger of a dry period some time in August or September. Where this condition is present and moisture becomes scarce, the trees receive a check in their growth

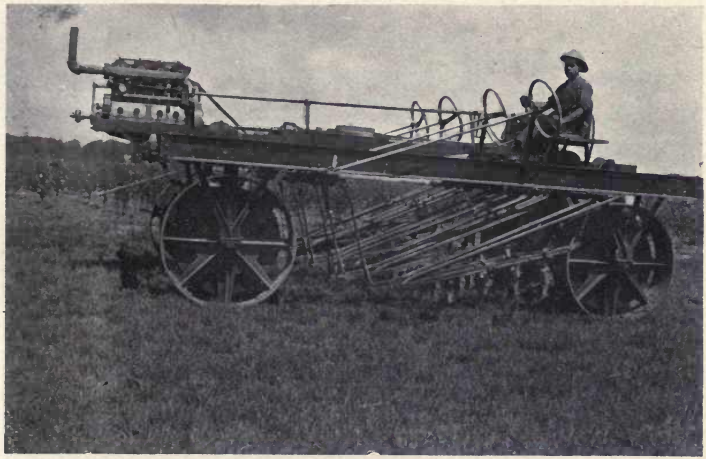


FIG. 60.—A Gasoline Tractor used for Cultivation.

which may result in the formation of terminal buds indicating the passing of the tree into a dormant stage. Where this occurs before the close of the normal-growing season a late rain may again start growth, which is always undesirable, producing a weak and abnormal condition. Such trees as may have this extra growth can easily be detected by the formation of the terminal bud rings with a few inches of lighter colored wood beyond.

Heading Back. This is a process of cutting off the tips of the young trees, in order to force more lateral branches and develop a more stocky trunk. Such fruits as peaches, apricots and cherries may grow so late into the fall that winter injury may result. The heading back checks this, besides giving a uniform height to all the

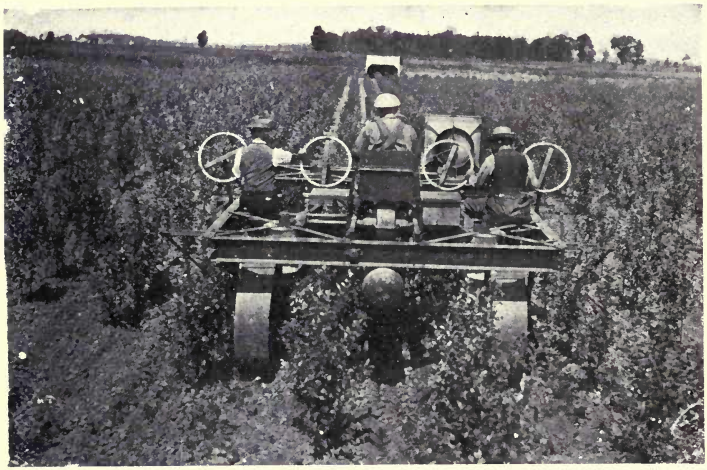


FIG. 61.—Cultivating Seventy Acres a Day by Gasoline Power.

trees. The pome fruits are not usually given this treatment. The operation is performed with an ordinary pruning shears. The operator walks along the row clipping the tops almost as fast as he can walk.

Trimming Up. Practically all nursery trees have the lower branches removed to a height of sixteen or eighteen inches when sold. This makes a neater looking tree and one that is easier to handle in shipping. The lower branches

are of no consequence to the tree, as they are weak and often poorly developed, due to the shading by the higher branches. Most nursery trees are grown very close together, often no more than two or three inches apart in the row. After growth is well under way little sunshine gets through the thick tops and the bottom branches are starved for the want of food. This results in tall straight trees which so delight the nurserymen. If the young plants were allowed more room they would develop larger lateral branches, the trunks would be less straight, the tree would be oversized and in every way less desirable for a good orchard tree. The trimming of the trunks is done near the close of the growing season, leaving only a short time for the healing of the wounds before the trees are dug. A heavy knife with a curved blade is used for the pruning work. The operator works from the ground upward with short heavy strokes which require the use of both hands.

Spraying. The nurseryman, like the fruit-grower, is troubled with numerous insect pests and fungus diseases. These must be controlled by careful attention to spraying. Probably the worst of all the troubles of this kind would be the San José scale and the Root Knot. Plant lice sometimes become serious, while thrips and the yellow or red mites are frequently troublesome in the more arid regions of the southwest. The San José scale and the Root Knot are especially bad from the ease with which they may be carried with the nursery stock and spread over the country wherever the stock may be shipped. The former may be controlled by dormant sprays and isolation of infected areas, while the latter is a bacterial

disease and not amenable to spray treatments. Moreover the disease may remain in the soil from year to year and reinfect the succeeding plantings.

In former years where these troubles were less marked, there were no restrictions on the shipping of the stock, and as a result, many troubles were spread far and wide over the country. Now, most states have regulatory measures and nursery companies must submit their stock to a rigid inspection by some state official before it can be shipped. The Government also has official inspectors to regulate interstate shipments, and quarantine offices to look after stock that may be imported. While this work is recognized as being efficient in preventing the shipping of diseased stock, still, there is always a possible danger.

Spray Machines. Nursery work requires a special kind of spray outfit. Such an equipment must work rapidly, must cover several rows at once and be able to do the work while moving across the field. In many cases it is necessary to get the spray down along the trunk when the tops are very close and thick. Any machine that would be large enough to pass over the tops of the trees without damaging them, could not help but be awkward and unwieldy. Many types of such sprayers have been devised but the one shown in Fig. 62 has been worked successfully for a number of years. It was manufactured by the Greening Nursery Company of Munroe, Michigan, and will successfully spray the trees from ground to tips.

Counting the Trees. It is always desirable that nurserymen have an estimate of the number of salable trees

some time before they are ready to dig. Not all the trees will be good ones and those that have crooked trunks or are deformed in any way must be discarded. Those that are good go into different grades according to their height or degree of perfection. The counting is usually done with a small mechanical device which records the results auto-

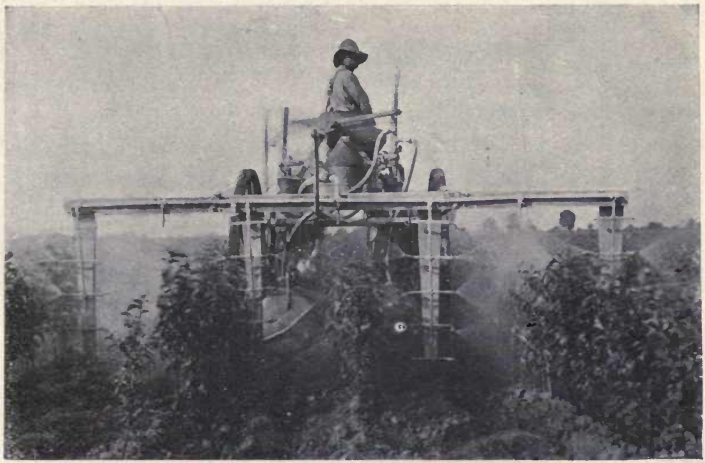


FIG. 62.—A Successful Nursery Spray Outfit.

matically. The operator walks along the row and as he glances at the trees he pulls the trips on the machine according to his estimate of the grade of the trees. With a little training one may count the trees and place them in grades as fast as one can walk. This estimate of the number of salable trees is turned into the office where they are segregated and turned over to the sales force, or published in the catalog.

Digging the Trees. In the fall the trees that are old enough to sell must be removed from the ground and placed in a storage house, where they can be graded and packed for shipping during the winter months. In a home nur-

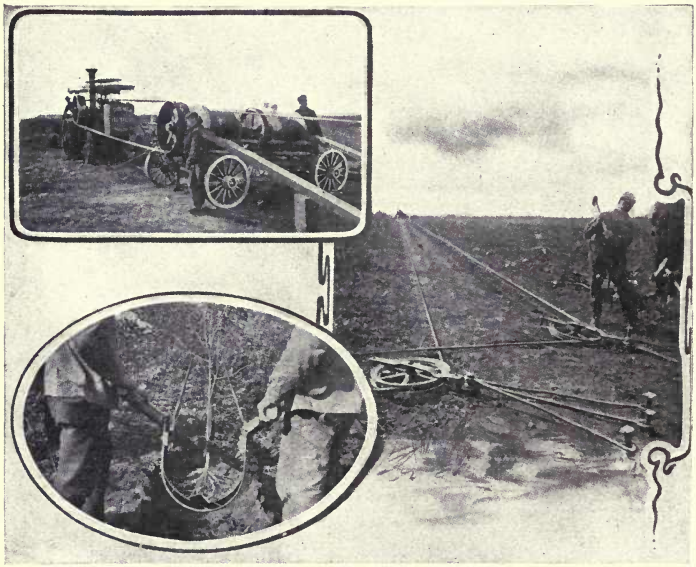


FIG. 63.—Steam Tree Digger in which the Share is Drawn by a Cable Pulled from a Stationary Engine and Drum.

sery, this digging is done with a spade, but where the number runs to only a few thousands this method is impractical. However, the spade is a poor tool and often severely damages the roots of the trees.

There are three kinds of mechanical diggers in use in various parts of the country. The cheaper and more com-

mon one is a special plow pulled by horses. This plow contains two beams, one on each side of the row. These are connected by a special U-shaped share which runs under the row cutting off the roots from sixteen to eighteen inches below the surface of the ground. The share does not lift the trees but passes on under them leaving them upright in their original position but loose enough that one man may easily pull them out. The other two types of diggers differ mainly in the kind of power used. Where steam power is used the engine is stationary, and the share is pulled across the field with wire cables. This method makes it necessary to plant the trees in blocks of only a few hundred feet across so that the cables will not be too long. It is also necessary to carry the share back each time as it will dig the trees only one way across the field. More recently gasoline tractors have been designed for this purpose with far better results than either of the other methods. With the steam outfit illustrated in Fig. 63 seven men are required for the operation, while with the tractor two men will do the same work and the trees can be dug both ways across the field. Long rows can be handled as easily as the short ones. As many as five to ten thousand trees an hour may be dug with one of these machines.

Pulling. After the digger has passed under the rows the next step is to pull out the trees and place them in piles ready for hauling to the storage shed. The trees are lifted out, the soil shaken from the roots, and a hasty examination made for *root knct* or defects that would spoil the sale of the plant. The poor ones are discarded and the good

ones are placed in piles of twenty-five or thirty each. These are followed by the wagon or truck which picks up the bundles and carries them to the storage sheds or fumigating house. The trees are piled on the wagons like loads of hay, placing the roots alternately to the outside of the load. The loader uses rubber-soled shoes and walks on the tops of the trees so very little damage is done. Care-

FIG. 64.—Pulling the Trees After the Digger Has Passed.

lessness in loading or handling may peel the bark from the trunk which makes the tree unfit for use.

Fumigation. In many states the fumigation of all nursery stock is required by law. In such states, the work is usually done while the trees are on the trucks enroute to the storage sheds. Special air-tight buildings are required for this work. They are usually just large enough to hold one truckload of trees. As they come from the

field they are driven into these sheds, the team removed, the building closed up and the trees exposed to the fumes of hydro-cyanic acid gas. This is used primarily against the scale insects and has little or no effect upon any of the fungus troubles. The process is always attended with some danger as the gas is extremely poisonous. It re-

FIG. 65.—Hauling the Trees to the Storage House.

quires from twenty to thirty minutes to fumigate a load of trees.

Storage Sheds. Where nursery trees are grown to any considerable extent, some arrangement will be necessary whereby the trees can be graded and packed for shipment during the winter months. Where the winters are too disagreeable to work out in the open, sheds must be provided. In the colder states these must be built substantial enough to hold a large number of trees and sufficiently

well insulated against the cold that the men may work comfortably. The majority of such buildings consist mainly of walls and roof as the floors are mostly of dirt. The interior is divided off into stalls or apartments by the posts or pillars that support the roof.

FIG. 66.—A Fumigating Building with Load of Trees Ready for the Gas.

As the trees are brought in from the field or fumigating house they are placed in these stalls. The bundles are tiered to a height of eight or ten feet, placing the roots to the outside the same as they were loaded on the truck. Narrow alleys are left when needed for the men to make examinations from time to time. The sections are filled with single varieties and no effort is made to label the

bundles until after they are regraded. Where the roots are exposed to the open air they are covered with moss, chaff or some material that will hold moisture and keep them from drying out. These stalls are examined occasionally and if there is any signs of drying out they are sprinkled with a hose. It is important that the roots

FIG. 67.—Trees as Stored in Cellars Previous to Grading.

remain fresh and moist until they are again planted in someone's orchard. Many nursery companies in the Gulf states or in California are able to dispense with these sheds, and instead, the trees are heeled-in out in the open where they are graded and packed for shipping.

Grading. After the trees have all been dug and stored for the winter the process of grading and labelling begins. The storage sheds are large enough that the stalls of trees

may be taken down, graded and labelled and restored in another part of the building. Here all the different varieties are collected in ricks so placed that the orders may be conveniently filled. All the trees are examined by experts and those not suited for selling, or those that are injured in any way are thrown out. The ones that are

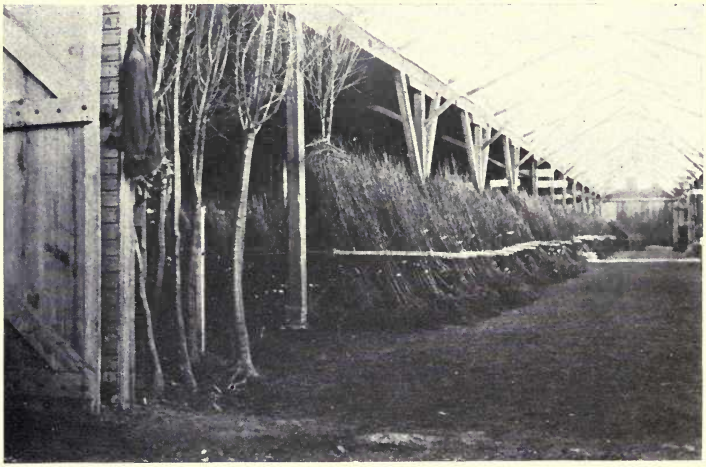


FIG. 68.—Trees in Ricks Ready for Filling Orders.

passed are taken to another grading table and sorted into grades or classes according to the size. The trees are placed in bundles of twenty-five each, pressed together and tied. A label is now placed on each bundle for future identification. Considerable skill is necessary to make a neat and attractive bundle. Where the trees are budded the slight curve at the union is turned so they all set in the same relative position, making a close compact bundle.

Grades of Trees. The term grade as applied to nursery trees is somewhat of a misnomer as it infers that some trees are better than others. What is really meant, is classes into which the trees are divided according to their size or caliper. Most grades are based on the height of the trees although some few companies also list the trunk diameter. It should not be inferred that a number one tree or a first-grade tree is the best to buy for orchard work. It often happens that this grade represents oversized trees which may be less desirable than the number twos or second-grade trees.

Most nursery companies list four grades or sizes of trees. Three of these usually represent stock two years from buds while the fourth is only one year's growth. A fair average of the different companies would represent a classification about as follows:

Grade 1	or	Class 1	or	X,	2	years	from bud;	5 to 6 feet.
" 2	"	2 "		XX,	2	"	"	4 to 5 "
" 3	"	3 "		XXX,	2	"	"	3 to 4 "
" 4	"	4 "		XXXX,	1	"	"	3 to 4 "

Sales Methods. Nursery companies that have to dispose of from one to two million trees annually have to develop a particularly strong sales force. There are but three channels through which the bulk of the stock reaches the orchardist. The oldest and probably the most common is through agents scattered over the various fruit sections. The second is the direct selling to the grower through the medium of the catalogue or what may be called a mail-order business. The third is the wholesaling to the jobbers

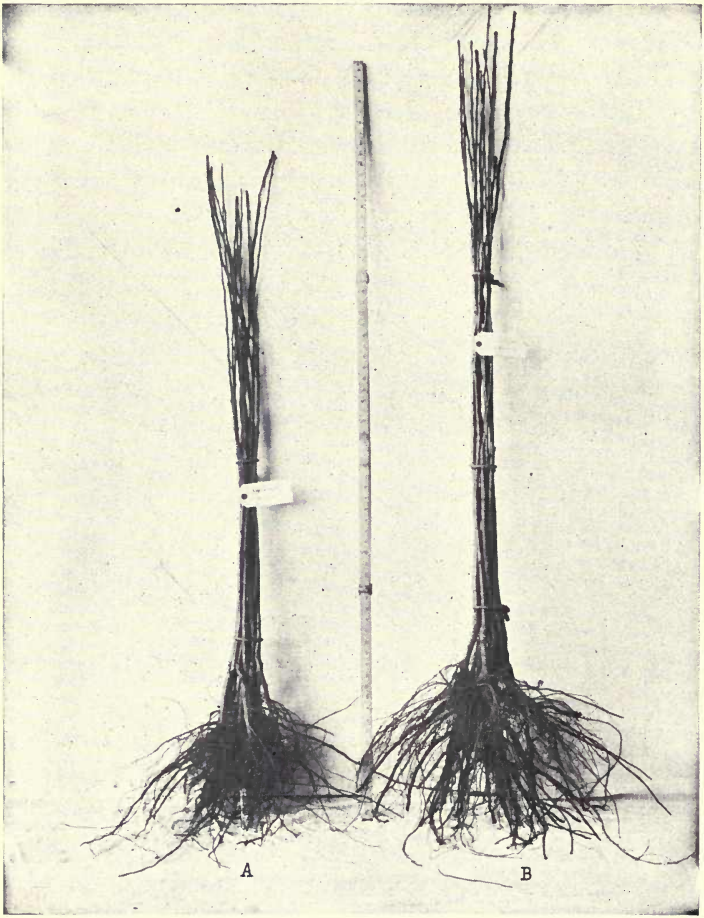


FIG. 69.—One-year Old Apple Grafts. *A*, 3 to 4 feet; *B*, 4 to 5 feet.

or small dealers. In only special cases do companies have salaried salesmen to call on the trade.

Sub-Agents. It is the policy of many companies to secure in each local fruit section a competent agent who will call upon the fruit men and solicit their business. These agents work on a commission which usually represents about forty per cent of the retail price of the trees. They are furnished with descriptive matter and order blanks which are filled in and forwarded to the company as fast as business is secured. These agents spend the winter in canvassing their territory and in the spring look after the delivery of the trees and make the collections. Where such agents are reliable and trustworthy men the plan is highly successful, especially in sections where fruit growing is not highly developed. They often help the general farmer in selecting a few trees for family use and may stimulate to an active interest a desire for fruit that has been lying dormant, purely from the lack of ability to make the initial effort. It is no unkindness to persuade a general farmer to buy a few trees for home use provided the trees are reliable and suited to the local conditions. Such agents should be well known in their own community, they should be willing to furnish references for themselves and the company for which they are working at any time, and they should not ask for any money until the trees are delivered.

Catalog Selling. The present trend of the business is to deal more directly with the companies and less through sub-agents. Fruitmen who are well versed in the business do not care to listen to the tales of the agents. They represent, for the most part, a more intelligent class and prefer

to investigate a number of companies before placing their order. Many college man are going into the fruit business and as a rule they are quite certain of just what they want. Nursery companies are well aware of these conditions and utilize their best efforts to get out catalogs that are true and accurate and will convey the information that the buyer wants. There are still many catalogs issued that are gaudy imitations of the real thing but few buyers are fooled by them.

A good catalog is well illustrated by photographs: they deceive less than the pen drawings. The descriptions are ample, often more so than necessary. Methods of propagation and the various tools used are often depicted which increases the interest and knowledge of the reader. Great mysteries and secret processes are no longer included. Companies realize that the catalogs represent them as their salesmen and in order to continue in business the goods that are delivered must be an exact duplication of the descriptions in the books. Good catalogs are expensive and it is not uncommon to invest from twenty to forty thousand dollars annually in their publication.

The prospective buyer who places his order from the study of catalogs, likes to have those from a dozen or more different companies to select from. He reads over carefully what each one has to say, draws his own conclusions and makes his own selections. Often his opinions are the result of his own experiments or inferences may be drawn from the study of government or state bulletins. In any case his judgment is apt to be quite correct and nurserymen like to cater to his opinions.

Jobbers or Dealers. In years gone by these people were looked on with suspicion. Times when laws were less strict and the buyers more trusting, much bad material was distributed among farmers. The jobber was often a newcomer in a local section. He would deal in trees for a few years and then vanish. Particularly about the time his first sales came into bearing. He had no reputation to maintain and it sometimes happened that a nursery company would sell to a jobber what the company would not care to sell to a grower; especially stipulating to the jobber that he should not disclose the source of his trees. All orders for all kinds of fruit were not infrequently made to order by the simple device of placing a label.

At the present time the situation is fairly well taken care of by the restrictive laws which safeguard the interests of the fruit grower. Only reliable firms are becoming dealers and the stranger that calls at the door of the grower is often asked embarrassing questions. His license to sell, the source of the stock he is offering and the inspection certificate issued by the proper state officials are some of the things that the buyer wants to know. Large nursery companies are now inclined to celebrate with large bonfires what were formerly the chief source of revenue to the nursery jobber.

Office Routine. This resolves itself into the most economic way of keeping records so the least possible number of mistakes will be made. The details of the business are legion. The possibility of error is far greater than for almost any other kind of work. The danger of using the wrong buds or cions, the possible mixing of varieties

when transferring to the storage sheds, the placing of the wrong label when the grading is done, clerical errors in the accounting department, and again, possible mistakes in the filling of the orders are just a few of the things that worry the manager of a nursery. Also the knowledge that any of these errors may be interpreted as criminal carelessness contributes no small amount to his troubles.

In this connection only a few of the fundamental principles involved can be cited. Order blanks, sufficient for the needs of most orders are sent out with each catalog. Full and detailed instructions are given wherever possible. When the order is received by the company it is copied in triplicate and a copy returned to the buyer. This passes as an acknowledgment and a receipt of the order. The buyer is further instructed to examine the copy and if it is not as desired to report at once. The original is sent to the order clerk, where it is filled, boxed up and made ready to ship when the proper season arrives. When the goods are shipped the original copy goes with the bill of lading for the buyer's use in comparing with the order. The third copy is kept in the office of the company for reference in case any mistake is made.

In spite of all these precautions errors will appear, and the buyer having little idea of the magnitude of the business often becomes caustic in his letters of inquiry. He creates countless trouble for the company by failing to mention the number on the order or to explain just what is missing. It often becomes necessary to sort out the complainant's order from fifty thousand others on the name and address alone. Then the company has to write back to ask just

what was missing and what the trouble was all about. It is only fair to say that the nursery companies are just as anxious as the buyers are to see that all mistakes are properly corrected and a simple letter of inquiry stating the facts is usually all that is necessary.

FIG. 70.—Packing Nursery Stock for Shipment.

Filling the Orders. The first four months of each year are the busy ones with nurseries. This is the rush time when all the orders are placed in packages ready for shipment when the proper season arrives. All orders are booked and filled in the order received. Those that come early

in the season get the pick of the stock. When one variety is sold out those who order late must go without or allow substitution. In order to keep track of the varieties, the total salable stock is carefully counted and as fast as the orders come in each variety is subtracted from the total. When the supply is exhausted the rest of the purchasers are notified. If the order is placed early, ample time is given to arrange with some other company.

Nursery stock may be packed in boxes, in bundles or is sometimes shipped loose in carloads to the sub-agents where they are distributed to the buyers. The important thing is that the trees shall reach the buyer with the roots in a moist and fresh condition. The roots are packed in moss or chaff and then covered with burlap to keep them from drying out. Those that are to go south are shipped first, and then as the season advances the ones that go north are started. There is no special advantage over the bale or the box. Probably large orders can best be handled in the latter. Whatever packing material can be used with the greatest economy is the one to have. When the stock leaves the hands of the company, even though handled under the very best possible conditions, no guarantee can be given as to the future success of the trees. This must rest with the buyer, which is another story.

REVIEW QUESTIONS

1. What nursery trees are usually grown in one year from bud or graft? What ones in two years?
2. How does this vary in the northern and southern states?
3. What summer culture is necessary for budded stock?

4. What is " heading back," its purpose and how done?
5. What trimming or pruning is required of nursery stock? How done?
6. What insect and fungus troubles are liable to affect nursery trees? What are the dangers?
7. What are the essentials of a good nursery spraying machine?
8. How are trees counted before digging and the purpose of the count?
9. Describe the process of tree digging and the various machines used.
10. What is the pulling process? How is it done?
11. How are nursery trees fumigated and what troubles is it supposed to control?
12. Describe a modern tree storage shed.
13. How are nursery trees graded?
14. What are the principal grades and what do they stand for?
15. What are the usual methods for selling trees?
16. Describe the sub-agent and his methods.
17. How are trees sold from catalogs?
18. What are the essentials of a good catalog?
19. Discuss the nursery jobber and his methods.
20. Mention some of the essentials in the office routine of a nursery company.
21. How are orders filled? What packages are used?
22. What are the necessary conditions for shipping live trees?

CHAPTER VIII

SOME GENERAL CONSIDERATIONS

Pedigree Nursery Stock. This is a much abused and a much misunderstood term. To the nurseryman it means one thing and to the scientist another. To the former it is interpreted to mean the careful selection of buds or cions from strong, vigorous healthy trees. It implies that extra efforts are made to make the trees true to name and represent the best strains of any particular variety. To the scientist, the term conveys the same meaning as it does when used in connection with animal breeding. It is our purpose to analyze these various uses and to see if some term cannot be found which may be accepted as a common definition.

The term "Pedigree," as used in nursery work, has no foundation for a comparison with animal breeding. The two processes have no biological relation. The one involves the mating of individuals which makes the progeny subject to all the laws of heredity; the other is simply the continuation of the same individual by dividing it into numerous pieces and growing them to maturity. It is somewhat unfortunate that the same word should have different meanings when applied to different subjects, but this is not uncommon in the English language.

As to the much argued question: "Is pedigreed stock

of any value," the answer is unquestionably in the affirmative. There has been much carelessness in the past among nurserymen in putting out trees that were not true-to-name. When an effort was begun to cut buds from trees whose records were known, the term " pedigree " became the natural means of advertising that effort. Most nurserymen have no intention of applying the meaning of the term to a better performance record for their trees, although there is sufficient evidence for that claim. Some scientists have argued that there is no foundation for the assertion that one bud on a particular tree may produce better results than another, but the evidence is to the contrary.

It will only be necessary in this connection to cite a few well recognized examples. Growers of geraniums, carnations and chrysanthemums have to continuously select their cuttings from bearing shoots in order to keep up the production of numerous flowers. Orange growers are not only selecting buds for propagation from trees with known records, but often from a particular branch of one of these trees. The vigor of particular varieties of fruit is most easily perpetuated by bud selection. Two Baldwin apple trees may vary widely in their ability to be strong pollenizers and this character is perpetuated by bud selection. A certain strain of pecans and Persian walnuts grown in the northern part of the United States are much more resistant to frost than others grown farther south. This quality is passed on by the use of buds or cions. When growing side by side, the Elberta peach which for several generations grew in northern Michigan blossomed several days earlier than the Elberta peach grown in California.

Double Working. This is a practice used to a limited extent by nurserymen in order to adapt varieties to special

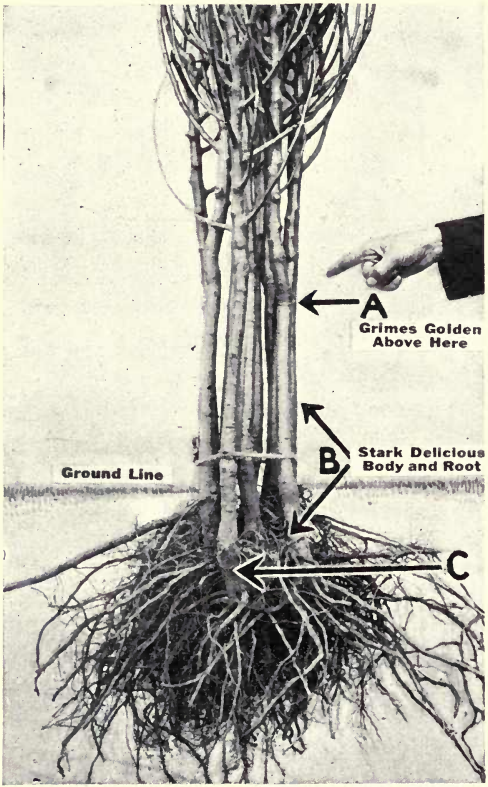


FIG. 71.—Double-worked Nursery Trees. Original "French Crab" Root.

conditions. It means that the variety is grafted or budded on two different stocks instead of one. The first graft or

bud is made in the usual way and then later a second budding is done. The process takes a year longer to grow a desirable tree and adds considerable to the expense of the work, yet the results often warrant the extra effort. The Baldwin apple grown in Maine is more resistant to the severe winter conditions when double worked on the Tolman Sweet. The Grimes Golden of the central states is increased in vigor and productiveness by double working. The Stark Brothers Nurseries use many nurse root cuttings of the Northern Spy and Stark Delicious apples because of their resistance to the woolly aphis. The cuttings are made long so they will eventually develop the major part of the root system.

Fruit trees that have weak or crooked trunks may be strengthened by double working. The Winter Nellis pear is an example of this kind. A good strong grower like the Kieffer is used for the main trunk, then the Winter Nellis is budded into the branches. Another feature of this practice is the shortening of the time required for trees to come into bearing. Apples that require from eight to ten years to produce fruit will bear in five to eight by double working. Pecan trees which have required twenty years to fruit as seedlings have been made to bear in ten by double working. The practice, however, is not recommended indiscriminately but only to fit the fruits into special conditions.

Influence of Stock on Cion. Every fruit grower knows that the kind of stock on which the fruit is grafted may produce a marked influence upon the resulting tree or fruit. But to what extent these influences represent fixed or

dependable qualities is still an open question. The best recognized example of this influence is the dwarfing of certain standard fruits when worked on smaller stature plants. Thus apples are worked upon doucine or paradise stock, or pears upon the quince for this purpose. Peaches are

FIG. 72.—Almond Grafted on Peach. Tree forty-two years old. Measures in circumference nine feet one inch above the union and ten feet 4 inches below.

dwarfed by working them on the common American plum while oranges and lemons are put on the citron.

While slow-growing stocks tend to reduce the stature of plants grafted upon them, the converse of this is also true, although probably to a lesser degree. While the quince as a stock will dwarf the pear the reversing of the process will tend to increase the stature of the quince. The French

crabapple commonly used as the stock for apples, is not a particularly large tree; yet in many cases if not in all, the more vigorous cions have stimulated the root system of the stock to a larger size than it would normally grow.

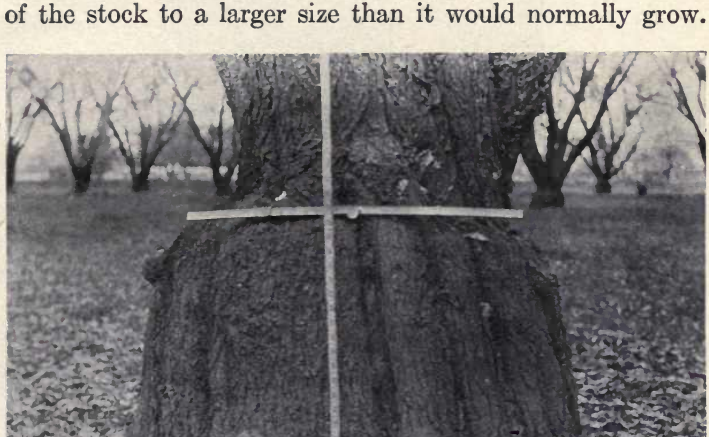


FIG. 73.—A Tree from the Same Orchard as Fig. 72. Measures six feet six inches above and nine feet seven inches below, making a difference in circumference of three feet one inch.

Peaches grafted on Myrobalan plum stock produce a larger root system than would develop if ungrafted.

Occasionally, instances are cited where both stock and cion are stimulated to a growth far greater than either would develop by themselves. Almonds grafted on peaches have developed a circumference of a little less than ten feet (Fig. 72), while the maximum size of either, growing alone,

would be scarcely five feet. Where almonds are grafted on plum stock, the reverse is true (Fig. 74). Where the

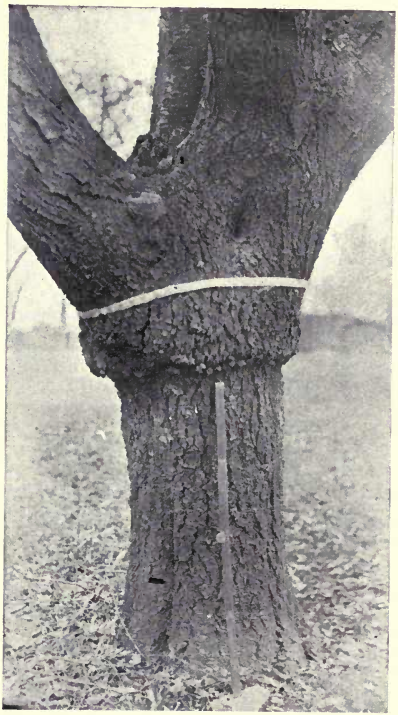


FIG. 74.—Almond on Plum Stock. Tree same age as Figs. 72 and 73. Circumference four feet below the union and four feet ten inches above. These trees were sickly and many of them had died.

union comes above ground there is almost always an increase in size at the point where the two parents are joined. Whichever parent represents the larger plant that part of

the union will be larger. This is well illustrated in Figs. 72, 73 and 74.

Another influence of stock over cion is the early bearing tendency of dwarfed trees. Orchardists everywhere recognize this factor and utilize it in a practical way. Pears on quince stock will fruit in three or four years while the standard stock requires from five to eight years. Apples

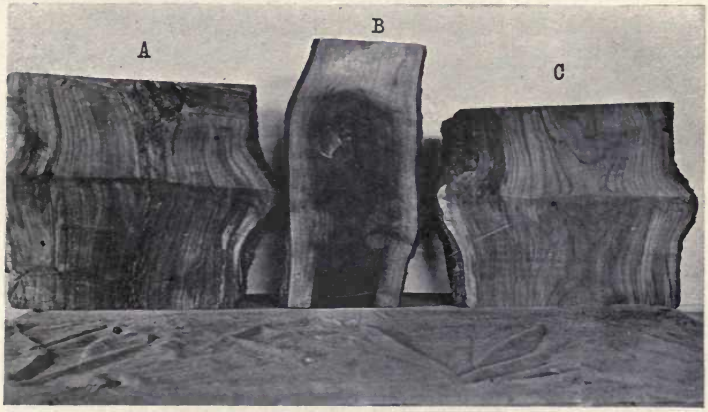


FIG. 75.—Cross Section through Union of Grafts. *A* and *C*, peach on almond; *B*, English walnut on black. The union is apparently as strong as any other part of the tree.

on paradise stock will fruit in three years while the same variety on French "crab" will require from five to eight years. In almost every case, this early bearing habit is associated with the dwarfing condition. Also in this same connection it is well to note that dwarfed trees are shorter lived than their full statured relatives.

Various other known conditions are attributed to this

reciprocal influence of grafts. For example, peaches or almonds may be retarded in their blooming period by working them on certain varieties of plums. Blossoms appear on plums from one to two weeks later than the almond. Where plum stock has been tried the delay has been about one-half the difference between the two blooming periods. In a similar way the maturity of certain varieties of plums may be hastened by working them on early varieties of peaches; although it is doubtful if this would ever be difference enough to be made use of in a practical way.

Color and flavor of fruits is also influenced more or less by the stock used, but the results are not so easily measured or so well understood. There apparently is no question but that high colored fruits can be improved by grafting on seedlings grown from high colored fruits. This, however, is more or less an indefinite quantity, as the seedlings themselves may vary widely in their ability to transmit the high color. Results are more noticeable when seedlings from Siberian crabs are used, because they are more stable.

What is true of color is also true of the sugar and acid content of the fruit. Apples low in sugar when grafted on sweet apple trees will show an increase in sugar content. Undoubtedly, some of the poor color and lack of quality in certain regions, attributed to local environment, may be due to the influence of the stock on which they are grafted. Claims have been made that the Baldwin apple after being grafted through several generations on the Tolman Sweet has developed a high sugar content.

As the stock may affect the maturity of the fruit so also

may it affect the keeping quality. The Duchess apple when top-worked on the Ben Davis will keep from four to six weeks longer than the same apple worked on the common stock.

The cause of these varied influences may be attributed to two sources—namely, mechanical and physiological disturbances. This can more easily be understood when we think of the cell as being the plant unit. Each cell performs its own functions. Theoretically the cells of the stock perform all those functions characteristic of the stock, up to the point of the union. Then the cells of the other co-parent take up the work from that point and modify the processes, in accordance with their own peculiar character. While there is a rather wide division of labor in the functioning powers of the cells of the different organs, there is a more or less definite protoplasmic organization throughout the entire plant tissue. Certain cell substances such as sugar may be differently affected by the cells of each of the co-parents. If the cells of the stock are capable of developing a higher sugar content than the cion, presumably the cells of the latter will not reduce it, hence an increase or decrease in the acid or sugar content is influenced by the stock. Of course this is relatively a very small amount and were it not the case the entire purpose of graftage would be lost.

In the case of dwarfed stock the cause is more mechanical. The root system of the slow growing plant is incapable of supplying sap as fast as the more rapidly-growing top demands, hence a reduction in size. Conversely the demands of the actively growing top stimulate the root

system to a greater effort, thus causing an increase in the size of the stock.

The early bearing habit of dwarfed trees may be explained on the theory that the diminished supply of sap tends to weaken the whole tree. Now the object of every plant, one may say, is to reproduce its kind; and when it finds itself weakening it seems to hasten this process of reproduction, in order to make sure that it may leave progeny before it dies. The dwarfed and weakened trees thus blossom and set fruit before their normal mates; and are correspondingly shorter lived, due to this weakening, in consequence of the mechanical restriction of the food supply.

Hardiness in Nursery Stock. Many questions are being asked at the present time if it is advisable to buy nursery stock a considerable distance from where it is to be planted, and especially if stock grown in the south is as resistant as northern grown stock to the rigorous winter conditions. While no specific experiments appear to have been tried to determine this point many observations from practical experience have been made. Nursery trees of every kind have been shipped far and wide and have therefore been tried under all kinds of conditions. Insofar as hardiness is concerned there appears to be no difference due to the locality in which the tree may be grown.

There are other considerations, however, which often make it advisable to secure stock as near as possible to the place where it is to be planted. The danger of introducing insects and diseases is greater when buying from a distance, and there is less chance to become personally acquainted

with the company, and the environmental conditions often make the tree unsuited to its new surroundings. The added cost of freight, danger of delay in transit and the possibility of the stock drying out are some of the objections to buying at long range. Increased hardiness among fruit trees can only be secured by breeding and selection, and when once produced can only be maintained by vegetative propagation. It should be understood, in this connection, that the hardiness or the resistance of any variety to the various troubles may be increased by working them on different roots. But if using the same root it does not matter in what part of the country the tree may be grown.

Horticultural Novelties. Due credit must be given to the nursery companies for their efforts in finding and introducing new and valuable varieties of fruits and flowers. It is true that many new plants have been introduced which have no particular merit, but it is also true that many of our most valuable varieties have come through the nursery companies. The motives which have actuated these companies in introducing new plants have been mostly financial, although many of them are spending time and money simply because they are interested and without any thought of remuneration. Among the present workers in the nursery business are many college-trained men. Their scientific training together with their abundant practical knowledge especially fits them to be leaders in this kind of work.

Some men like Burbank devote their entire energies to the creation of new kinds and then sell the right to introduce them to other companies. Some companies

maintain a scientific staff for the purpose of breeding new types, or to experiment with old varieties in order to better adapt them to peculiar or specific conditions. Most companies are always on the lookout for new and strange types or forms which may become a valuable novelty. They are trained to be keen observers and as they travel over the country they see many interesting things which the layman would pass by unnoticed.

By far the greater majority of novelties are discovered by accident. Some orchardist finds a seedling growing in his garden. He transfers it to his orchard with the intention of later grafting it into a desirable variety. This task is neglected and the tree grows up and bears desirable fruit. Thousand of seedlings are growing everywhere and it is not strange that some of them may be an improvement on existing varieties. A sample of the fruit is saved and sent to the nurseryman, he examines it and becomes interested. Correspondence follows, later a visit is made to the tree to study its vigor and productiveness; a contract is drawn giving the company the exclusive right to propagate and sell the fruit. A number of cions are cut, a few trees are propagated and planted in their trial orchard. If they appear desirable the variety is named and sent out to the public. All this consumes from five to eight years and it is only reasonable to expect that a higher price should be asked.

Many new plants are now coming, through the activities of the department of plant introductions of the U. S. Department of Agriculture. Nursery companies are always willing to coöperate in the testing of these introductions.

Few of them are found valuable but all have an equal chance in their dissemination. The state experiment stations and the trial grounds of the various Agricultural Colleges offer an efficient check against any imposition on the people by the nursery companies. They make it their business to secure samples of all novelties as soon as offered to the trade and grow them in their trial grounds. If they fall too far short of the claims made by the introducers the public is notified through the medium of the press.

Nursery Inspection Laws. Every state in the union now has some kind of a law for the purpose of preventing the shipping of nursery stock infested with insects or fungus troubles. Not every disease or insect is serious enough to cause the destruction of the stock but a number are, which makes the regulatory measures necessary. Practically all of these state laws are patterned after the same general plan. All companies intending to sell stock either in their own state or other states must file their intentions with the proper state official and make application for inspection of their stock. The officer in charge of this work varies considerably in the different states. In some the State Horticulturist does the inspection, in others the Commissioner of Agriculture, in some it is in charge of the Agricultural Colleges, while in one or two cases State Entomologists do the work.

The work of inspection consists mostly in the visiting of each nursery once or twice during the year and making a close examination for insects or fungus troubles. If the stock is found clean, an official certificate is given which

is the nurseryman's authority for making the shipments. Every package that is sent out must contain one of these certificates of inspection. These are not necessarily valid for interstate shipments. Every state reserves the right to reinspect all nursery stock shipped in from outside. Certificates that are good in one state may or may not be acceptable in others. The only sure way is for the shipper to secure copies of the law in states in which he intends to do business and inform himself on the requirements before attempting to make any deliveries.

The insect pests or diseases that will prevent the shipping or selling of stock vary somewhat in the different states but the chief ones are the following:

Insects	Diseases
Brown tail moth.	Black knot of cherry and plum.
Gypsy moth.	Crown gall.
Mexican cotton-boll weevil.	Hairy root.
San José scale.	Rosette of peach and plum.
West Indian peach scale.	Yellows of peach.
Woolly aphis.	White pine blister rust.

In the northern states some of these are of no particular consequence while further south some that are not on the above list are included. In Florida the Mango Weevel and the Fruit Fly are among the troublesome ones.

Federal Horticultural Board. The regulatory measures passed by the various states are not all of the laws with which the dealers or growers of nursery stock have to contend. There have been certain questions pertaining to the importation of plants from other countries and the quarantining of certain areas to prevent the spread of diseases, which could

only be handled by the Federal Government. To provide for this need Congress in 1912 passed the "Plant Quarantine Act" and established the "Federal Horticultural Board." This Board is in charge of five men drawn from the Bureau of Plant Industry, the Bureau of Forestry and the Bureau of Entomology.

The aim of the Quarantine Act was to enable the government to prevent the introduction of dangerous plant diseases or insect pests and to prevent the spread of serious infestations to new territory. The Secretary of Agriculture was given far reaching power in the making of rules and regulations which might be applied to almost any contingency that might arise. This application may extend to every kind of living plants, excepting only field, flower and vegetable seed and the more common bulbs.

The members of the Board are empowered to make rules and regulations governing the procedure of all nurserymen who desire to make importations. All stock or seed brought into the United States must be inspected at the port of entry by experts and if found infested is destroyed. The Board also has the power to say what stock may not be imported or from what particular countries importations are restricted. Any state or district within the United States may be quarantined at any time if it is deemed necessary to prevent the spread of dangerous insect pest or fungus troubles.

On July the first, 1914, the Federal Horticultural Board put into operation ten specific regulations, all of which may effect the Nursery Man. These regulations are still in force to-day and every shipper of stock should familiarize

himself with these rules. The headquarters of the Board is at Washington, D. C., to which all inquiries should be directed. The chief concern to the nurseryman over the enforcing of these regulations will likely be the importation of seed and stock used in propagation. It is now necessary in all cases to make application to the Board for a permit which will entitle the holder to make importations. Blanks are furnished the applicant to fill out in which the following information is required: The time of importation, the locality and country in which the plants are grown, the name and address of the exporters, the port of entry, and the company or firm which is receiving the goods.

All importations are divided into two classes; those coming from countries which maintain a nursery stock inspection and those countries which do not. In the case of the former the Board has authority to accept the certificate of inspection from the foreign government if they consider them efficient, in all others the stock must be inspected at the port of entry. Where inspections are made stock found infested with dangerous troubles are destroyed. If the proposed importations are to be used for experimental purposes a separate permit must be secured giving in addition to the other information the exact designation of the plants to be imported. These regulations of the Federal Horticultural Board in no way satisfies the laws of the various states and the nursery companies must see that their own state law is complied with. In most cases, however, the state officials are willing to accept the certification made by the Board.

Another regulation of the Federal Board gives them

authority to quarantine any state or section of the country where dangerous outbreaks of insect pests or fungus troubles may occur. This may not only affect interstate shipments of nursery stock but shipments between different sections of the same state. Such quarantines may be permanent or temporary according to the judgment of the officials of the Board. Wherever such acts are contemplated public hearings are provided for where interested parties may appear and give evidence concerning the subject of the hearing. This serves as a check against hasty action and gives all interested nurserymen an opportunity for free discussion.

REVIEW QUESTIONS

1. Explain the meaning of " Pedigree Nursery Stock."
2. Discuss the application of Pedigree Stock to nursery work.
3. Explain " Double Working " of stock, its value and use.
4. What is meant by " Influence of Stock over Cion"?
5. State some known effects of Stock on Cion or Cion on Stock.
6. Give instances where the above is made use of in a commercial way.
7. Give the theory in explanation of the reciprocal influence of Stock and Cion.
8. Discuss hardiness in nursery stock and the extent to which it may be influenced by climatic conditions.
9. What relation does hardiness bear to the place where nursery stock is purchased?
10. What are Horticultutal Novelties?
11. What should be the orchardists attitude toward novelties?
12. To what extent do nursery companies aid in the improving of fruits?

13. Give the nurseryman's viewpoint regarding the introduction of new fruits.

14. Why are laws for the inspection of nurseries necessary?

15. How is the work of inspecting nurseries conducted?

16. What particular troubles will prevent the shipping of nursery stock?

17. What is the Federal Horticultural Board?

18. What relation has this Board to the various state inspection laws?

19. How may the rulings of the Board affect nurserymen?

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